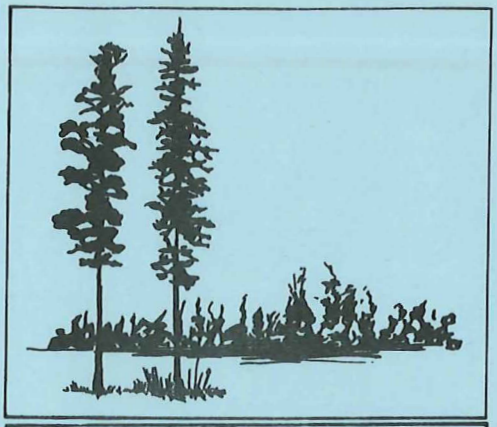

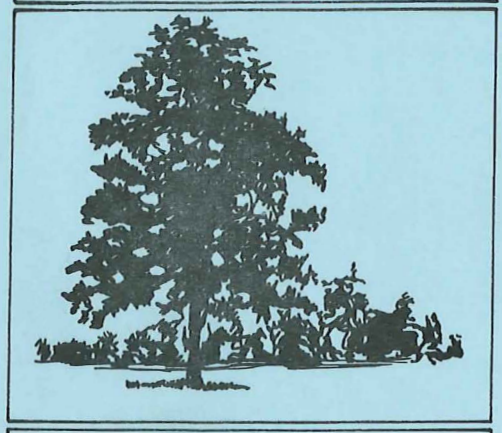

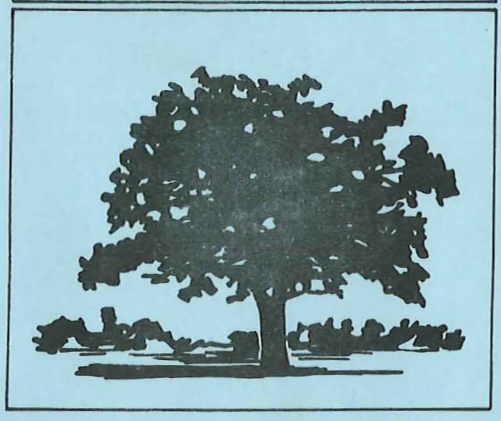

DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

# FOREST PEST CONDITIONS IN WISCONSIN

# ANNUAL REPORT 1986

# FOREST PEST CONDITIONS IN WISCONSIN ANNUAL REPORT - 1986

*Compiled and Edited by Allen J. Prey, David J. Hall, and Jane E. Cummings*

**DEPARTMENT OF NATURAL RESOURCES**
Division of Resource Management
Bureau of Forestry

ACKNOWLEDGEMENTS

This record of the activities of forest pests and other destructive agents of growing trees in Wisconsin's forest nurseries, plantations, and natural timber areas was made possible by the dedicated work of pest management personnel in each district and at the Forest Pest Management Laboratory in Madison. DNR foresters, other Department field personnel, cooperators in other public agencies and private forest industry contributed valuable assistance in monitoring the forest lands in all classes of forest ownership.

There were some personnel changes and additions to the forest pest management program in Wisconsin in 1986. John R. Trobaugh was hired on September 2, 1986, as Laboratory Technician at the Forest Pest Laboratory at Madison. John replaced Beth A. Schuh who was promoted to administrative assistant in the DNR Bureau of Water Grants, Madison.

Preparation of this Annual Report was a result of a team effort involving William Kearby, Frank Morse and Shane Weber, DNR District Entomologists who submitted district reports. Jane Cummings and Dave Hall, Forest Pest Unit, Madison, consolidated the District reports and wrote the final draft. John Trobaugh, Forest Pest Unit, prepared the computer generated and hand drawn maps and Peg Shields of the Southern District Program Services did the word processing. Final printing was done by the DNR Bureau of Program Services.

Allen J. Prey
Supervisor, Forest Pest Management
March 30, 1987

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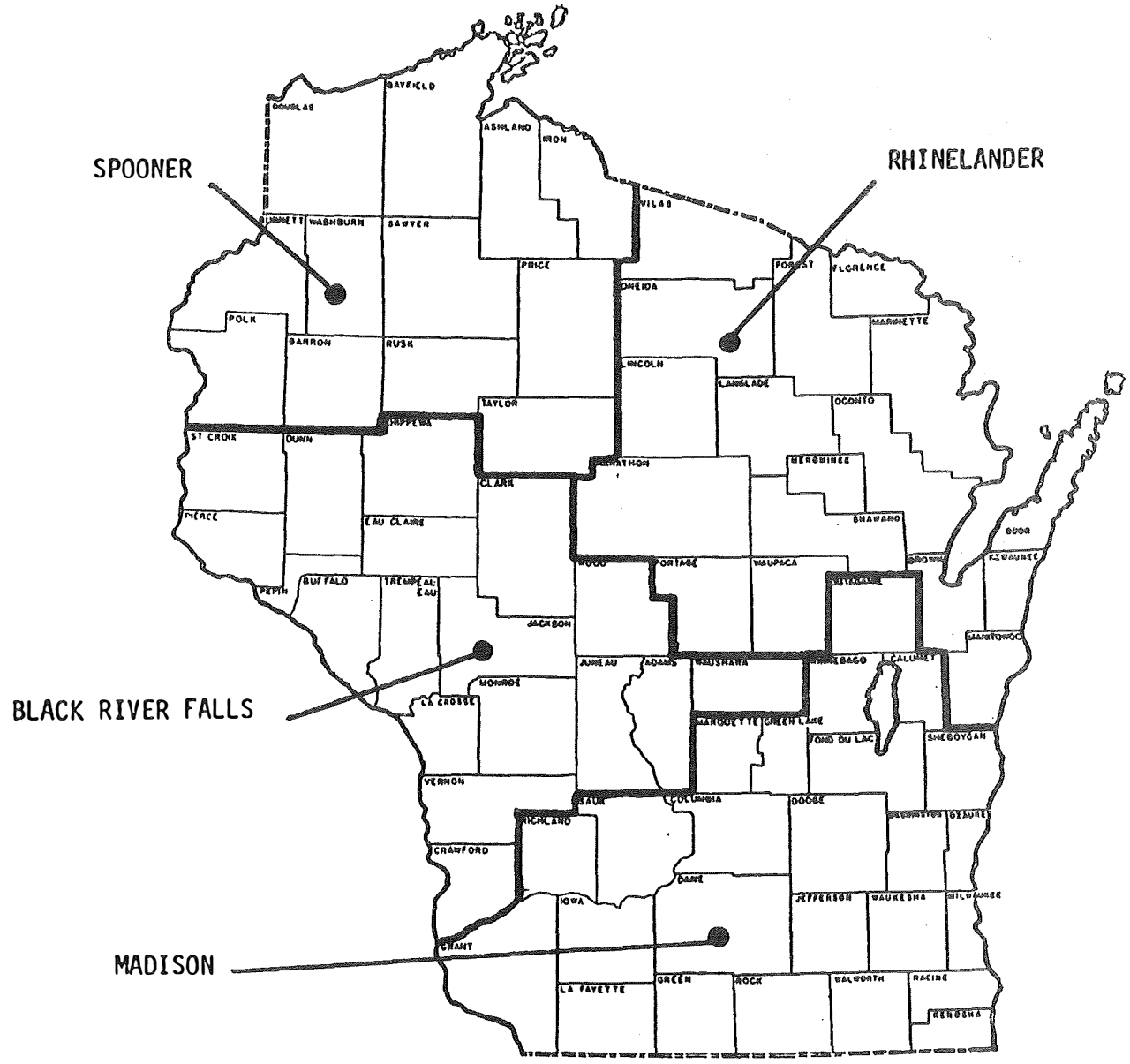


Figure 1. Station locations of Wisconsin Department of Natural Resources District Entomologists and Forest Pest Unit Personnel.

Department of Natural Resources
Forest Pest Management Personnel December 31, 1986

| Name | Title | Address | Telephone |
|---|---|---|---|
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| Hall, David J. | Forest Entomologist | DNR, 3911 Fish Hatchery Road, Madison, WI 53711 | 608-275-3275 |
| Cummings, Jane E. | Forest Pathologist | DNR, 3911 Fish Hatchery Road, Madison, WI 53711 | 608-275-3273 |
| Trobaugh, John R. | Lab Technician | DNR, 3911 Fish Hatchery Road, Madison, WI 53711 | 608-275-3237 |
| Kearby, William H. | Forest Entomologist | DNR, Box 818<br>107 Sutliff Avenue<br>Rhinelander, WI 54501 | 715-362-7616 |
| Morse, Frank S. | Forest Entomologist | DNR, Rt. 4, Box 5<br>Black River Falls, WI 54615 | 715-284-5301 |
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| Storandt, James F. | Assist. Nursery Supt./Pathologist | DNR, Griffith Nursery<br>711 Nepco Lake Road<br>Wis. Rapids, WI 54494 | 715-424-3700 |

## Introduction

This report lists the major insect and disease problems reported on forest land in Wisconsin in 1986. While this report does not list all the insect and disease problems that occurred on forest land, it does highlight major or noteworthy insect infestations, and disease occurrences including abiotic damage to trees.

In addition to surveying 8.5 million acres of forest land for pests in 1986, DNR district entomologists and forest pest staff continued to teach integrated pest management principles to DNR foresters, industrial foresters and private woodland owners. Approximately 2,500 individuals were trained at 39 sessions in 1986. Oak pest management training sessions were held at Shawano, Wisconsin in July and Portage, Wisconsin in October. An exhibit displaying common forest pests plus new posters on "Basswood Thrips", "IPM in Seed Orchards", "Red Pine Pocket Mortality" and "Chestnut Blight" were prepared and presented at a DNR statewide forestry meeting in Green Bay, July, 1988. Also the forest pest unit co-hosted an "IPM Symposium for Northern Forests" in Madison, March, 1986. Approximately 150 scientists, pest managers and forest managers from northeastern and north-central United States attended.

A forest pest exhibit displaying forest pest leaflets and free pest diagnostic services were available at the Wisconsin Christmas Tree Producers annual summer meeting at Wausau in July. Approximately 200 growers were helped with pest problems. Christmas tree insect and disease information was also presented at the Christmas Tree Producers winter meeting in Green Bay, Wisconsin in January. The same day a lecture and slide presentation on minimizing decay in hardwoods was given to 150 people at the Northeast Wisconsin Woodland Owners Conference held in Green Bay. Similar forest pest exhibits specifically designed to provide technical assistance for woodland owners and general public were displayed at Wisconsin Woodland Owners Association annual meeting in Stevens Point, Wisconsin in September. Forest pest staff also participated in a Wisconsin Walnut Council field trip in September at Richland Center, Wisconsin. The staff presented lectures on insect and disease problems of black walnut to approximately 150 walnut growers. The forest pest staff also provided technical and logistic support for a regional vegetation management tour held in Rhinelander, Wisconsin in September.

Three workshops on forestry and forest pest management were conducted at a Madison Blackhawk Council Girl Scout Career Day program in Madison, Wisconsin. The forestry workshop was featured on local T.V. Also members of the forest pest unit assisted at a forestry information booth and exhibit at farm progress days at DeForest, Wisconsin, October 7 and 8, 1986.

A new training program on hazardous tree recognition was developed by the DNR forest pathologist and was presented to electric utilities powerline right of way supervisors and workers as part of a forest fire prevention program. This was a training package for powerline right of way crews to recognize hazardous trees and thus prevent fires to forests and structures caused by falling trees and limbs. Also, formal training in hazardous tree recognition was held for DNR northwest district parks personnel at Pattison State Park in September.

Air pollution injury to white pine in Walworth County was shown to a group of German foresters and scientists visiting the United States to examine the acid rain situation in North America. Also a formal presentation comparing the forest resources of Wisconsin and Germany was given at the Wisconsin Center, University of Wisconsin - Madison. The status of acid deposition in Wisconsin and possible effect on the forest resource was also covered.

Teaching the safe use of pesticides and assisting the University of Wisconsin Extension with pesticide applicator training continued to be a responsibility of the entire forest pest management staff. Each district entomologist continued to be the district pesticide coordinator in charge of numerous DNR activities such as pesticide use, reporting, permits and certifications. Publications included a revised "Herbicides for Forest Management" publication that was printed and distributed to all DNR forestry personnel.

"Herbicides for Forest Management" computerized files were updated with 1986 label revisions and Christmas tree herbicides added to the file. A rough draft of "Pesticides for Forest Nurseries" was developed by the forest pathologist and a U.W. student intern.

The testing of a systemic insecticide continued in the red pine seed orchard at Avoca. The results of 1984 evaluations were accepted for publication in the Northern Journal of Applied Forestry.

A pest alert "Red Pine Pocket Mortality - Unknown Cause" was published. This alert printed by the U.S. Forest Service was distributed throughout the northeastern United States. A cooperative study with the University of Wisconsin - Madison on determining the cause of pocket mortality was initiated in 1986. An aerial survey was also conducted for red pine pocket mortality along the lower Wisconsin river valley. Several new pockets were found and color 35mm infrared photos were taken of some of the pockets. The entire forest pest unit is cooperating with Dr. Raffa and Dr. Smalley, University of Wisconsin-Madison in investigating the cause of the pocket mortality. Root and root collar weevils were trapped weekly and trees planted in pockets to observe possible future mortality.

An article on "Red Pine Pocket Mortality" originally published in Country Today resulted in statewide press releases and radio reports on the problem.

The forest pathologist condemned approximately 400,000 white pine seedlings at Wilson State Nursery because they had a root rot of unknown origin. Members of an interagency nursery disease control SWAT team drafted a resolution encouraging the bureau of forestry to support research on this problem.

Outplanted white pine seedlings from Wilson Nursery were evaluated and it appears that the culling procedure developed by the forest pathologist prevented diseased seedlings from being distributed.

Injury to forest vegetation in southern Rock County caused by the soybean herbicide "Command" was investigated. Lable recommendations are being changed for the herbicide based on this incidence and similar situations in the midwest.

Information on ash yellows and walnut canker was presented at the Tri-State Forestry Conference at Onalaska in October. Also a presentation on "Ash Yellows in the Midwest" was given to the Natural Resource Board in October.

A seminar on bruce spanworm, basswood thrips and yellow birch dieback in Wisconsin was presented at the Department of Entomology, University of Minnesota.

Lectures and laboratory sessions in forest entomology and forest pathology were presented at the University of Wisconsin - Stevens Point. Also, a seminar on the status of red spruce decline in Vermont was presented at the Department of Plant Pathology, University of Wisconsin - Madison.

A slide series and lecture titled "Your Friends the Insects" was presented at the Northern Unit Kettle Moraine State Forest Nature Center in August and Oregon, Wisconsin elementary school in September.

The forest pest staff participated in various national and regional meetings and conferences in 1986. The forest pathologist gave a presentation on "A History of Decline and Mortality of Sugar Maple in Wisconsin" at the North American Maple Syrup Council meeting, in Rutland, Vermont, in October. She also met with Dr. Dale Bergdahl, forest pathologist, University of Vermont, and examined red spruce decline in the Green Mountains. A slide talk on "Acid Rain and Sugar Maple Health in Wisconsin" was presented to the DNR Acid Rain Research Council.

Other conferences and workshops attended were the American Phytopatholocial Society annual meeting and field trip, Orlando, Florida in August; the Western International Forest Disease Work Conference, Juneau, Alaska, September; the North Central Forest Pest Workshop in Sault Ste. Marie, Ontario, Canada, October; the Entomological Society of America Annual Meeting at Reno, Nevada, December; and the North Central Weed Control Conference in Milwaukee, Wisconsin, in December.

ASPEN

**Aspen Bronzing** - Unknown

One new location of aspen with bronzing symptoms was observed in Barnes Township, Bayfield County (Figure 2) (T44N, R9W). Several dozen large-toothed aspen east and west of Highway 27 showed symptoms of bronzing in July and August.

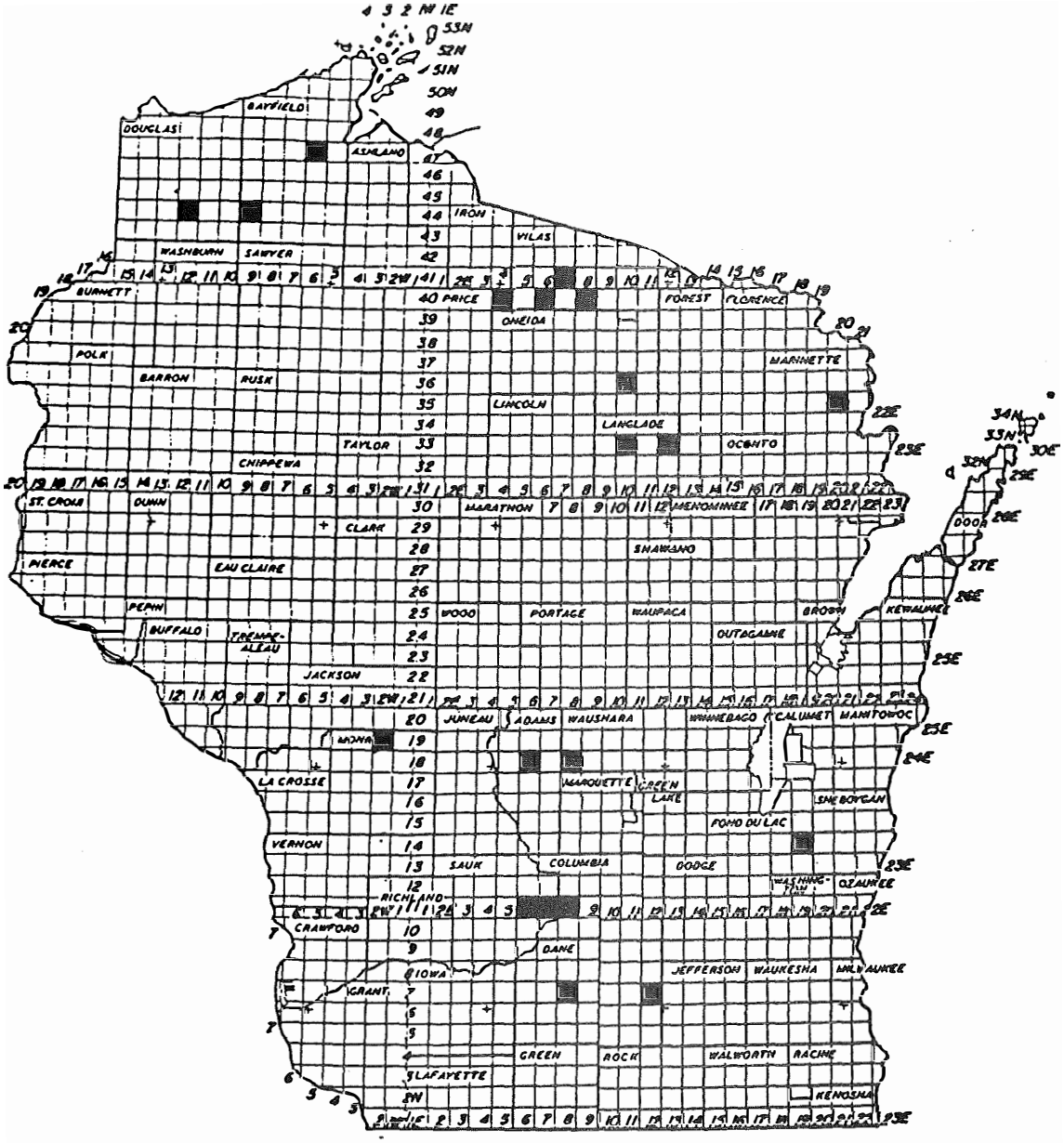


Figure 2. Township locations of Aspen Bronzing in Wisconsin - 1986.

**Aspen Leaf Rust** - Melampsora medusae Thum.

Incidence was light throughout northwestern Wisconsin; also reported in Dunn County, west-central Wisconsin.

**Forest Tent Caterpillar** - Malacosoma disstria (Hubner)

About 60 acres of mature aspen was 75 - 100% defoliated in the town of Wolf River in Langlade County. Calosoma beetles were observed feeding on the tent caterpillar larvae.

Phenological note:

May 28 - Larvae are nearly full grown in Langlade County.

**Aspen Tortrix** - Choristoneura conflictana (Walker)

A 10 acre pocket of moderate to heavy defoliation of aspen occurred in Bayfield County.

BALSAM FIR - SPRUCE

**Spruce Budworm** - Choristoneura fumiferana (Clemens)

Populations in northern Wisconsin declined in 1986. Only light defoliation was observed in Ashland and Sawyer counties.

**Balsam Gall Midge** - Paradiplosis tumifex (Gagne)

Light damage to balsam fir Christmas trees was observed in Langlade County.

**Balsam Twig Aphid** - Mindarus abietinus (Koch)

Light to heavy populations were observed in balsam fir Christmas trees in Langlade, Jackson and Waushara counties. A heavy infestation was observed on white spruce Christmas trees in Columbia County.

**Yellowheaded Spruce Sawfly** - Pikonema alaskensis (Rohwer)

Populations were greatly reduced from 1985 levels but some isolated heavy populations defoliated white spruce throughout the northwestern counties.

BASSWOOD

**Basswood Thrips** - Sericothrips tiliae (Hood)

Defoliation of basswood increased in area and intensity over much of Wisconsin (Figure 3). An outbreak that apparently collapsed in 1985 in the northwestern counties reappeared this year where the basswood component of about 200,000 acres of northern hardwoods suffered light to severe defoliation. Some crown dieback and epicormic branching was observed in previously infested basswoods in Sawyer County.

Light to moderate defoliation occurred on about 50,000 acres in the Timme's Hill area of Price and Taylor counties.

The large infestation in the northeastern counties increased in area and intensity. Within this area, pockets of light to heavy defoliation occurred. In eastern Langlade and western Menominee counties, basswoods were 50 - 90% defoliated. Pockets of light to heavy defoliation of basswood occurred over a large area of Door County.

Other reports of thrips damage were received from Clark, Fond du Lac, Dunn, St. Croix and Iowa counties.

Phenological notes:

May 8 - First feeding observed on open buds and small leaves in Iowa and Rusk counties.

May 15 - First feeding observed on open buds and small leaves in Forest and Menominee counties. Counts of 4 - 7 adults per bud were observed.

May 29 - Nymphs have appeared on basswood foliage in eastern Langlade and western Menominee counties.

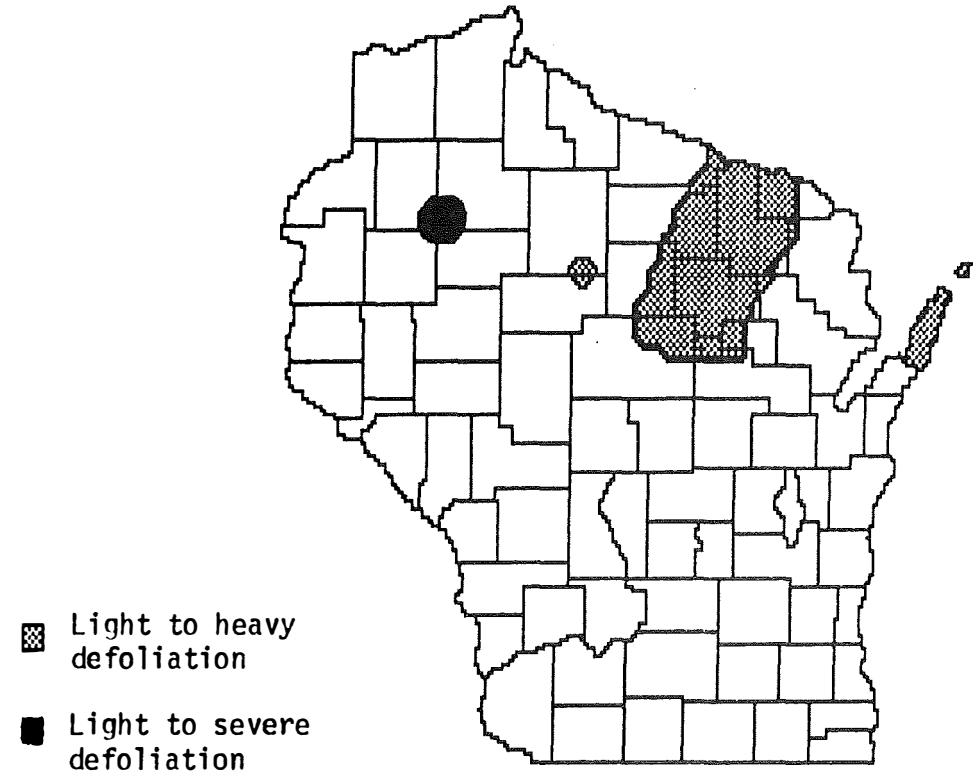


Figure 3. Area of Basswood Thrips defoliation in northern Wisconsin - 1986.

BIRCH

**Birch Leafminer** - Fenusa pusilla (Lepeletier)

Populations generally remained at low levels. Some light to moderate populations damaged forest trees in northwestern Wisconsin where some ornamentals were heavily damaged. Some light to heavy defoliation occurred in Vilas and Oneida counties with the heaviest concentration in the Woodruff area.

**Birch Skeletonizer** - Bucculatrix canadensisella (Chambers)

No defoliation occurred where a 5000 acre population collapsed last year in Douglas County (T46N, R12W).

**Yellow Birch Dieback** - Unknown

Top dying of yellow birch in northern Wisconsin was first observed in 1984. The dieback has continued at different rates in different parts of the state. In Rusk County, trees continued to show branch dieback and many trees died.

On the Flambeau River State Forest in Sawyer County, more branches appeared to leaf out this year giving the appearance of healthier crowns. Approximately 110 acres of yellow birch - hemlock forest will be salvage logged on the Flambeau River State Forest in 1987 because of the dieback. In Florence and Menominee counties where light mortality was observed, an increase in the growth and production of shoots in the lower crowns occurred. Most trees still have up to two-thirds of their upper crown dead.

BUTTERNUT

**Butternut canker** - Sirococcus clavigignenti-juglandacearum. Nair, Kostichka and Kuntz

In 1986, butternut canker was isolated from dying butternut on the Menominee Indian Reservation. Even though this is a new county location, the canker appears to have been present on the reservation for several years. Butternut canker has now been observed in 22 counties (Figure 4).

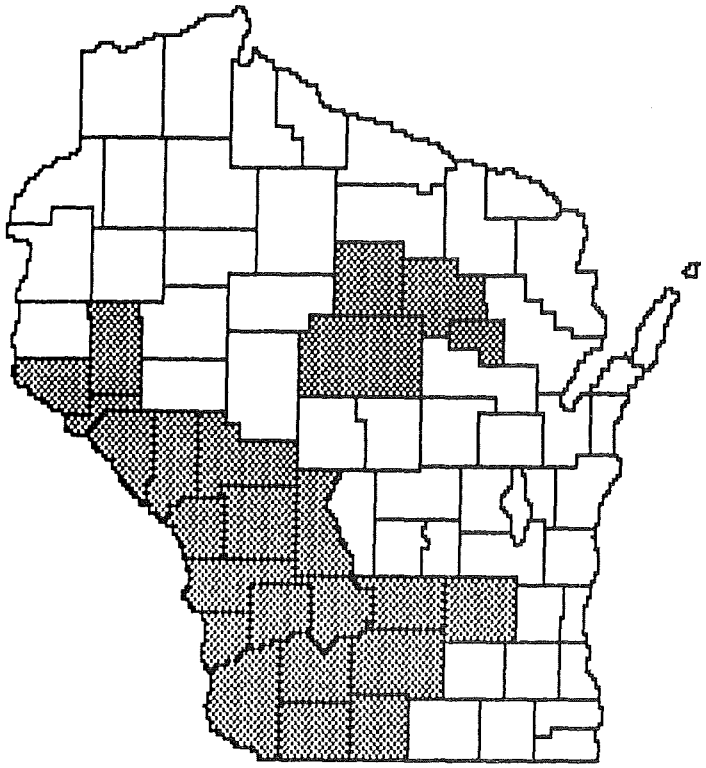

Figure 4. Known county locations of Butternut Canker in Wisconsin - 1986.

CHERRY

**Cherry Scallop Shell Moth** - Hydria prunivorata (Ferguson)

No infestations were observed in Jackson County where locally heavy infestations existed in recent years.

CHESTNUT

**Chestnut Blight** - Endothia parasitica (Murrill) Anderson and Anderson

Wisconsin is not part of the natural range of chestnut, but since the early 1900's, chestnut trees have been planted throughout the state. In 1986, the first observation of chestnut blight in the state was made in Richland County (T9N, R2W, S34) in southwestern Wisconsin (Figure 5). A survey of this area revealed 31 chestnut trees, 21 infected, and 10 without symptoms of the blight. According to a biology teacher at UW - Richland Center who takes his classes out to observe the trees, the first tree died in 1983. The trees are scattered on approximately 10 acres of a mixed hardwood woodlot. Pending landowner permission, introduction of the hypovirulent strain is planned.

A second finding of chestnut blight was made in October in Sauk County, (T10N, R6E, S6) southwestern Wisconsin (Figure 5). Four dead chestnuts and one infected sapling were observed. The trees are in a mixed hardwood woodlot on a steep north facing slope.

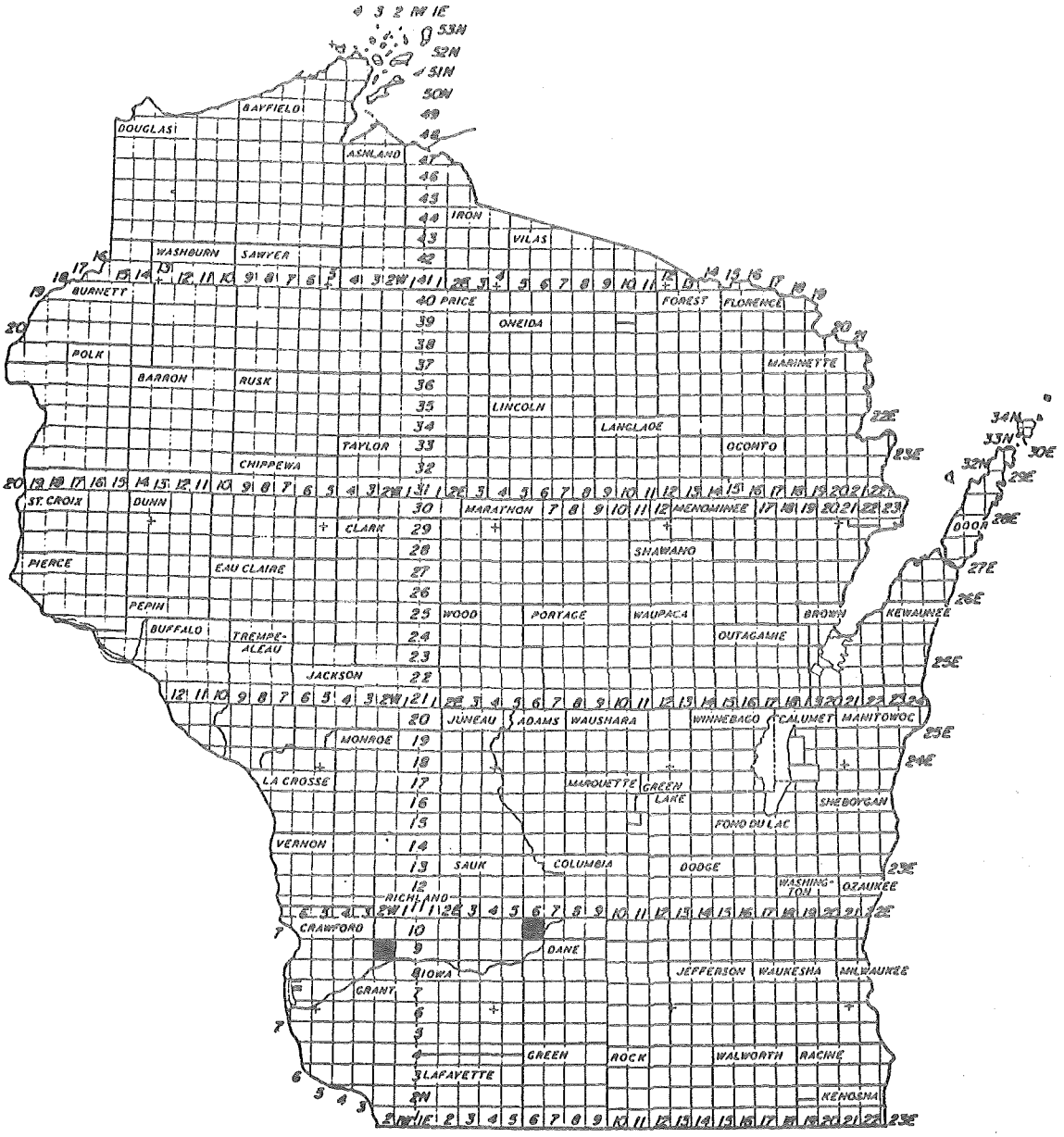


Figure 5. Township locations of Chestnut Blight in Wisconsin - 1986.

LARCH

**Larch Needlecast** - Mycosphaerella laricina (Hartig) Neg.

Mycosphaerella needlecast of European larch was first reported in Wisconsin and North America in 1980. In 1984, researchers from the U.S. Forest Service, North Central Forest Experiment Station, initiated a study to determine the host range by planting six species of larch and hybrids from twenty-one seed sources. The trees were planted adjacent to an infested plantation on the Coulee Experimental Forest in LaCrosse County. In 1986, the second year of data collection, trees from all seed sources were infected, but to varying degrees. Western larch was severely affected with none of the three sources exhibiting variation in resistance. Tamarack was infected for the second year in a row, although it has not been affected in natural stands. Japanese larch and four sources of European larch showed signs of resistance. Two hybrid larch sources were intermediate in resistance. A third year of disease severity data will be collected. A chemical control trial showed that benomyl applied four times throughout the growing season provided excellent control of Mycosphaerella. Chlorothalonil was phytotoxic. A manuscript on this study is in preparation.

Larch seedlings at the Wilson and Griffith State forest tree nurseries were surveyed for the presence of larch needlecast and no needlecast was found.

**Larch Sawfly** - Pristiphora erichsonii (Hartig)

Populations remained generally low statewide with little change from last years levels.

An eleven-year-old, one acre European larch planting in Clark County suffered heavy defoliation. Little or no mortality is expected.

MAPLE

**Bruce Spanworm** - Operophtera bruceata (Hulst)

Populations declined in old infestations but increased in new infestations so that over 100,000 acres of maple were defoliated in Florence, Langlade and Marathon counties. Moderate defoliation was reported in Price, Ashland and Rusk counties.

Extremely high numbers of moths were reported in Langlade, Oneida, Lincoln, Menominee, Forest, Florence and Vilas counties, in late October and early November.

Phenological notes:

May 14 - Larvae in 2nd - 4th instar in Menominee County.

**Greenstriped Mapleworm** - Dryocampa rubicunda (Fab.)

Hordes of moths were reported in Polk, Burnett, Washburn and Barron counties from June 2 - 4. They were reported to be covering the sides of houses in Cumberland. No subsequent defoliation was reported.

**Maple Petiole Borer** - Caulocampus acericaulis (MacGillivray)

Leaf drop of occasional ornamental maples was reported in the northern one-fourth of Wisconsin and in Jefferson County.

**Sapstreak** - Ceratocystis coerulescens (Munch)

Sapstreak disease was isolated from sugar maple on the Menominee Indian Reservation in 1984. In 1986, further sampling was carried out in southwestern Menominee County. Four trees with dieback and dwarfed leaves were cut and analyzed for sapstreak. Basal or stem wounds were present on all sample trees and all four trees were positive for the presence of sapstreak. In all areas sampled, logging had occurred within the last five years.

A cooperative study between the Menominee Tribal Enterprise, DNR, and the USDA Forest Service, was initiated to further document the incidence of sapstreak and the relationship between basal wounds and sapstreak. In 1987, wounded sugar maple along skid trails and nonwounded sugar maple will be monitored for symptoms of decline and infection.

**Sugar Maple Decline** - Unknown

See Appendix B for a history of the insect and disease pests affecting sugar maple in Wisconsin since 1953.

As a result of mortality of sugar maple in Quebec, forest managers, maple syrup producers and the general public have taken an interest in the health of sugar maple in Wisconsin. Members of the acid rain section and forest pest management in the DNR Bureaus of Air Management and Forestry toured part of the Reynolds sugar bush near Aniwa, in north-central Wisconsin. Insect and disease pests such as the sugar maple borer, Eutypella canker, decay fungus Coryolus versicolor, and Armillaria root rot were observed. A study plan was developed to determine the incidence of dead and declining sugar maple in a sample of the sugar bushes in Wisconsin. This two to three year study will begin in 1987 and will be a cooperative effort between the DNR Bureaus of Air Management and Forestry.

The USDA Forest Service, DNR Forest Pest Management and DNR Acid Rain Section will cooperate in a two year survey of decline and mortality of sugar maple across the rain pH gradient in Wisconsin. This study will begin in 1987 and combine aerial color infrared photography with ground surveys to:

1. quantify the number, volume, and basal area of dead and declining sugar maples;

2. determine the incidence of decline and mortality within two age classes across the pH gradient; and

3. quantify the decline and mortality associated with insect and disease pests.

OAK

**Actinopelte Leaf Spot** - Actinopelte dryina (Sacc.) (Hoehn)

In 1985, leaf spotting from Actinopelte was common on red, black, white and northern pin oaks in northwestern Wisconsin. In 1986, no Actinopelte was reported in northwestern Wisconsin.

**Strumella Canker** - Strumella coryneoidea Sacc.

A natural stand of red oak in Iowa County, (T7N, R2E, S27), was heavily infected with Strumella canker. The pole sized red oaks, average dbh, 8", covered three acres. Thirty to forty trees were infected and most infected trees were in a ravine. No sawtimber infections were observed.

**Oak Webworm** - Archips fervidanus (Clemens)

Populations continued at very low levels in Douglas and Bayfield counties.

**Oak Wilt** - Cerctocystis fagacearum (Bretz) Hunt

No new county locations of oak wilt were observed (Figure 6), but new locations within previously reported counties were detected in Marinette and Shawano counties, and around Legend Lake in Menominee County. Aerial surveys revealed 11 pockets of oak wilt in Marinette County, eight pockets were detected in 1985, three in 1986. Six of these infection centers are along the Menominee river, east of Wausaukee, one is approximately seven miles southwest of Wausaukee, and four are one mile northwest of Wausaukee, on Long Lake (Figure 7). Most of these pockets are located around homes.

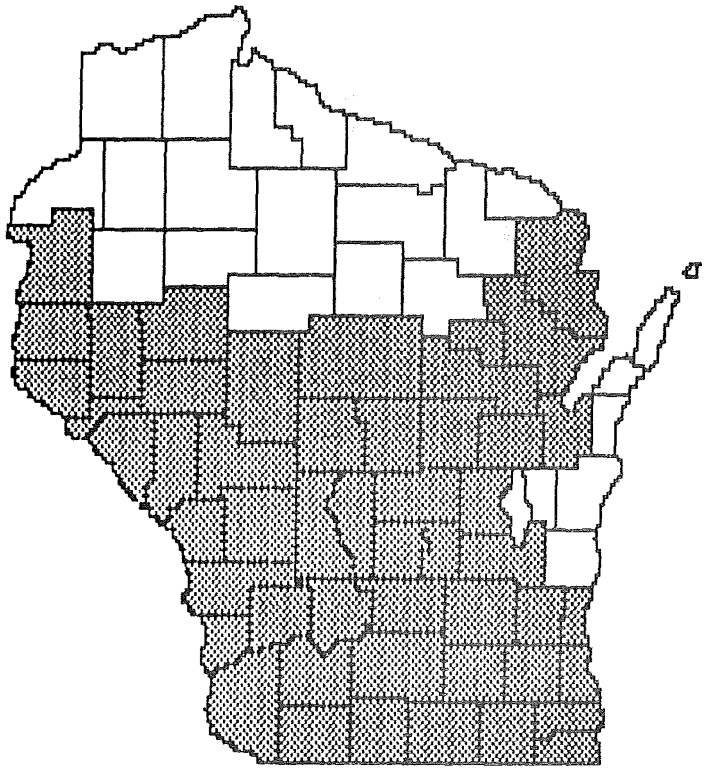

Figure 6. Known county distribution of Oak Wilt in Wisconsin - 1986.

In Shawano County, oak wilt continues to spread west and north of Shawano Lake and west and north of Round, and Grass lakes (Figure 8).

Since 1982, oak wilt has slowly spread in the Legend Lake area in Menominee County and in 1986, nine new pockets were observed which brings the total to 24. All pockets in the Legend Lake area are trenched and root grafts are broken to prevent the spread of the oak wilt fungus. All infected wood is removed and destroyed before the spring of the year following detection.

The intensive survey and control efforts will continue in northeastern Wisconsin in 1987.

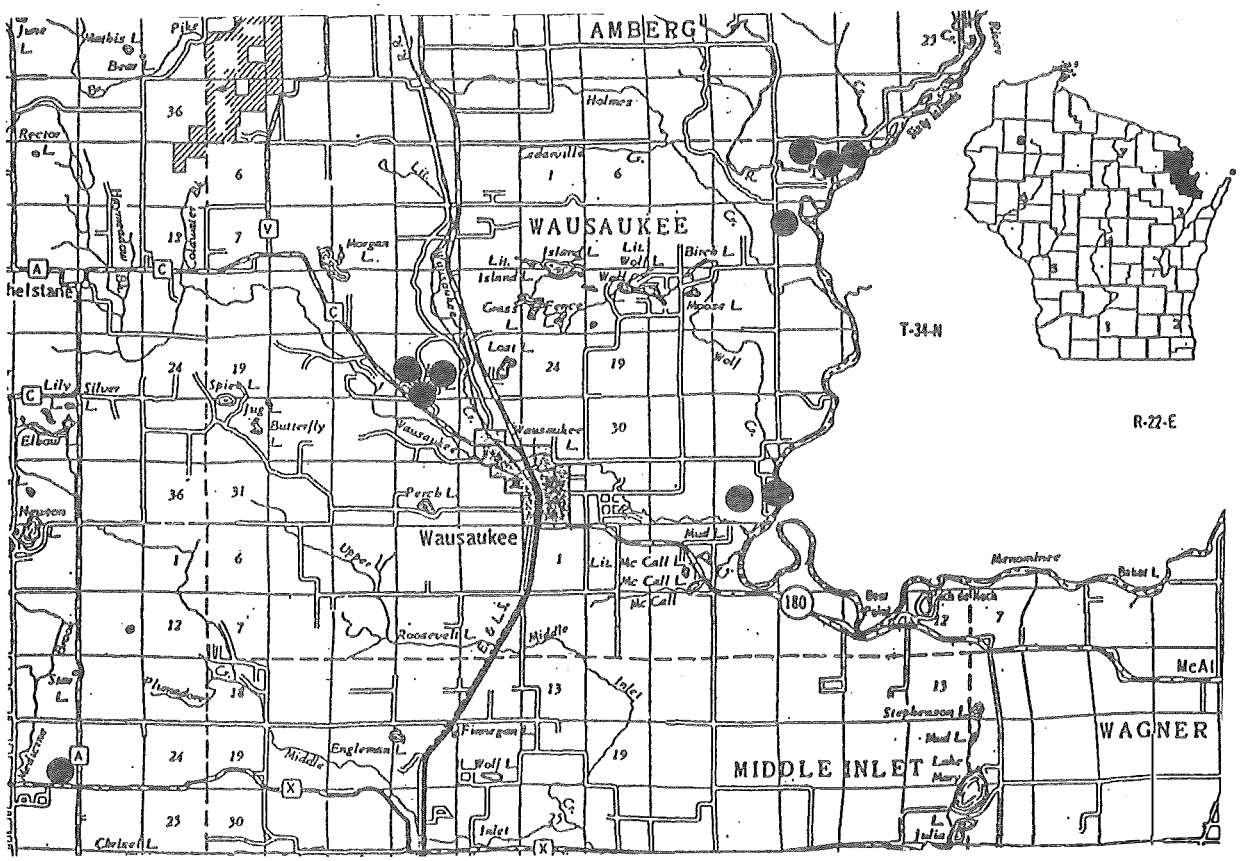


Figure 7. Locations of Oak Wilt pockets in Marinette County, Wisconsin - 1986.

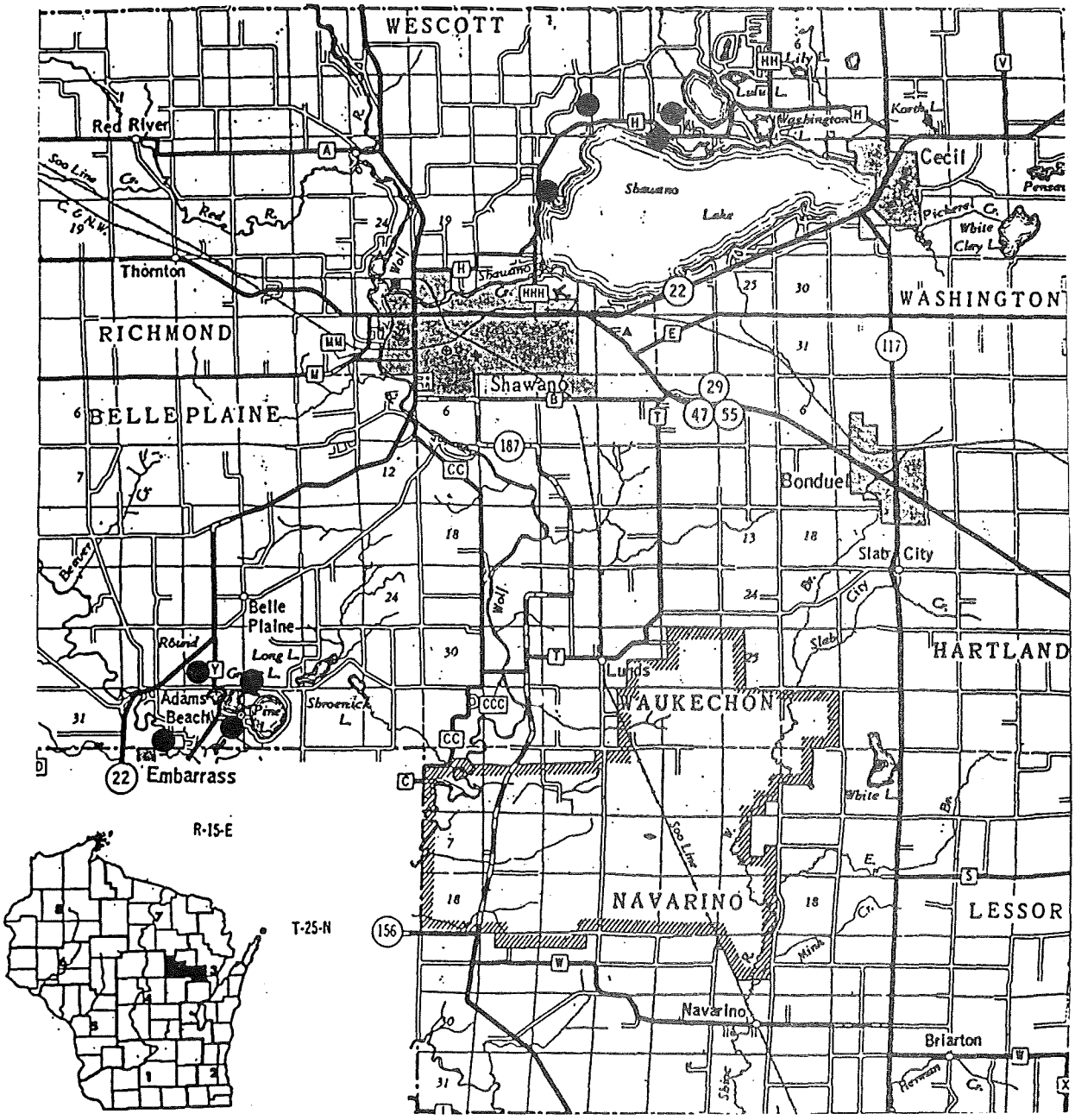


Figure 8. Locations of Oak Wilt pockets in Shawano County, Wisconsin - 1986.

**Fall Cankerworm** - Alsophila pometaria (Harris)

An outbreak which began in 1985 in several south-central counties declined drastically in area and intensity this year. The decline was due to severe frosts on May 2 and 3 that killed the buds on oaks over a large area in south-central Wisconsin. Some heavy defoliation of oaks, birch, soft maple and basswood occurred adjacent to Lake Wisconsin in Sauk and Columbia counties where the trees were protected from the frost. Scattered pockets of light defoliation were observed in Columbia County.

Phenological note:

May 14 - Larvae are 1/2 to 3/4 inch long.

**Post Oak Locust** - Dendrotettix quercus Packard

Populations were light and scattered in Jackson County. No noticeable defoliation was reported.

**A Leaf Gall Maker** - Dryophanta sp.

Damage to white oak foliage was almost undetectable in Dane County this year.

**Twolined Chestnut Borer** - Agrilus bilineatus (Weber)

Oak mortality increased slightly from the very low levels of the past several years. A few red oaks died in the area defoliated by cankerworms in Columbia County.

PINE

**Diplodia Canker and Shoot Blight** - Sphaeropsis sapinea (Fr.) Dyke and Sutton

In 1984, Diplodia canker and shoot blight was scattered throughout red and jack pine plantations and natural stands in Douglas County in northwestern Wisconsin. A survey has been conducted annually in two red pine plantations in Douglas County and in 1986, trees infected with Diplodia increased 7.7% in one plantation and 3.0% in the other. Mortality increased 0.5% and 0.2%, respectively. A total of 13.0% of the trees in both survey areas are now infected with Diplodia, and 1.05% of the infected trees have died.

Red pine seedlings at the Griffith Nursery, Wisconsin Rapids, and Wilson Nursery, Boscobel, were infected with Diplodia shoot blight. Infected beds were sprayed with Benlate to protect new growth.

**Scleroderris Canker** - Ascocalyx abietina (Lagerb.) Schlapfer-Bernhard

A new area of infection was observed in Douglas County, a county not previously reported (Figure 9). This new location, (T45N, R10W, S23, SWSW), has very light infection on an eight-year-old, 40 acre plantation in Highland township on industrial forest land.

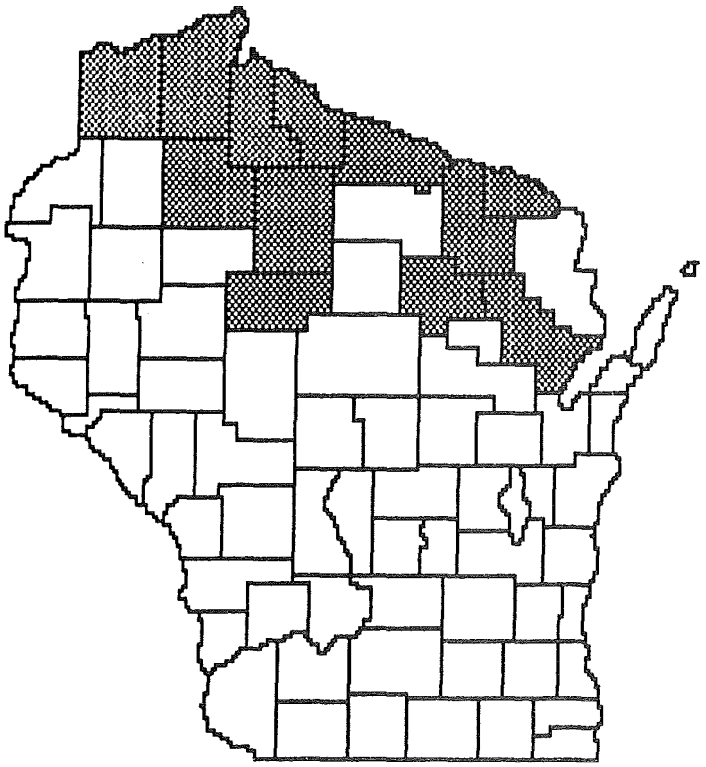

Figure 9. Known county locations of Scleroderris canker - 1986.

A survey was conducted in Bayfield, Douglas, Washburn and Burnett counties for the presence of Scleroderris on red pine. Plantations less than fifteen years old were surveyed. Twenty-four areas ranging from 10 to 640 acres were surveyed. In Bayfield county, where Scleroderris has been previously observed, one new area of infection was observed in Barnes Township on the County forest (T45N, R9W, S3). Very light scattered infection occurred on this 640 acre, 12-year-old plantation. A survey of disease incidence in this infected plantation, and the new location observed in Douglas County, is planned for 1987.

**Red Pine Shoot Blight** - Sirococcus strobilinus (Pruess)

No new county locations were observed in 1986 (Figure 10), but a new area of heavy infection was observed in Bayfield County (T49N, R6W, S14), on the Chequamegon National Forest. The infected stand was approximately 12 years old and growing under a light overstory that had heavily infected crowns.

Observations were made of red pine in Vilas County (T41N, R7E, S24), on plots that had been established in 1972 to determine the development of red pine shoot blight over several years. Disease incidence has decreased since 1984. Forty percent of the trees surveyed have died from red pine shoot blight. On the living trees, shoot infection was light ( 5%) for 84% of the trees, and moderate to heavy (15 to 90%) for 16% of the trees. Suppressed trees with foliage 20% or less of the total height, continue to die. Co-dominant trees are exhibiting foliage of 30 to 40% of the total height, and have minimal tip infections.

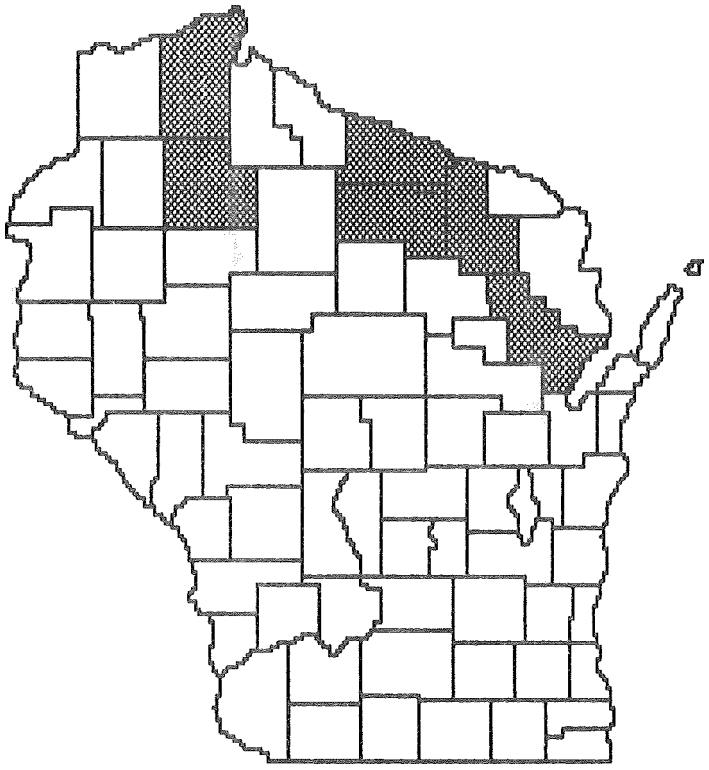

Figure 10. Known county locations of Red Pine Shoot Blight - 1986.

**Red Pine Decline and Pocket Mortality** - Unknown

Pockets of declining and dying red pine in 35 to 40-year-old plantations and windbreaks have been observed throughout central and southern Wisconsin for several years. The symptoms of affected trees are: reduced leader and branch-tip growth, loss of older needles, and fading of needle color.

In 1986, six new pockets were investigated. The summary of pests found are listed in Table 1. As of January 1, 1987, 16 red pine pockets have been investigated (Figure 11). Known pockets in Sauk and Iowa counties continue to expand.

Two projects were initiated to investigate possible causes of mortality. The Forest Pest Management Unit, in cooperation with the University of Wisconsin - Madison, Department of Entomology, developed a survey trapping system for Hylobius weevils. A trap was designed and 100 traps were placed in five plantations. An array of 20 traps caught from 0 to 20 adult weevils in an 11-day period. Detailed results will be the subject of a future publication.

A detailed study by Dr. Ken Raffa and Dr. Eugene Smalley at the University of Wisconsin - Madison was initiated in 1986. Their goals are to:

1. Determine the sequence of events that leads to mortality by monitoring insect and fungus populations and interactions in red pine pockets.

2. Determine behavior patterns of root weevils that are active in the pockets.

3. Determine what the reactions of the trees are to fungal infections occurring under different stress conditions.

TABLE 1. Locations of red pine decline and mortality investigated in 1986.

| County | Legal Description | Disease Description |
|---|---|---|
| Dunn | T29N, R11W, S11 | A 22 acre, 36-year-old plantation, thinned in 1982 and 1986. Two pockets are present with approximately 12 trees dead and dying in each. Pests present - root collar weevil and skidder damage. |
| Dunn | T29N, R14W, S28 | A 3 acre, 35-year-old plantation that has never been thinned. Approximately 5 trees dead. Pests present - turpentine beetle and Armillaria root rot. |
| Dunn | T29N, R11W, S14 | A 37-year old plantation, 50 acres, thinned in 1979 and 1984. In the two pockets in this stand, all the dead and dying trees were removed in 1984, and trees continued to die in 1985 and '86. Pests observed - bark beetles, turpentine beetle, unsuccessful weevil attacks. |
| Juneau | T17N, R3E, S1 NE¼ NE¼ | A 35-year-old plantation that has never been thinned. There are two pockets present; one has eight trees dead. Pests present - root collar weevil, bark beetles, turpentine beetle. The second pocket has approximately 23 trees dead, and most of the dead trees have been cut out. Pests present - root collar weevil, turpentine beetle. |
| Wood | T22N, R5E, S15 W½ SW¼ | A 34-year-old plantation, thinned once, extensively pocketed with areas of mortality. There is a dense understory of red pine seelings present. A clear cut was recommended for this stand. Pests observed - turpentine beetle, northern pine weevil. |
| Wood | T22N, R5E, S16 NW¼ SE¼ | A 35-year-old plantation, thinned once. Mortality is greatest on the southern quarter of the stand. |

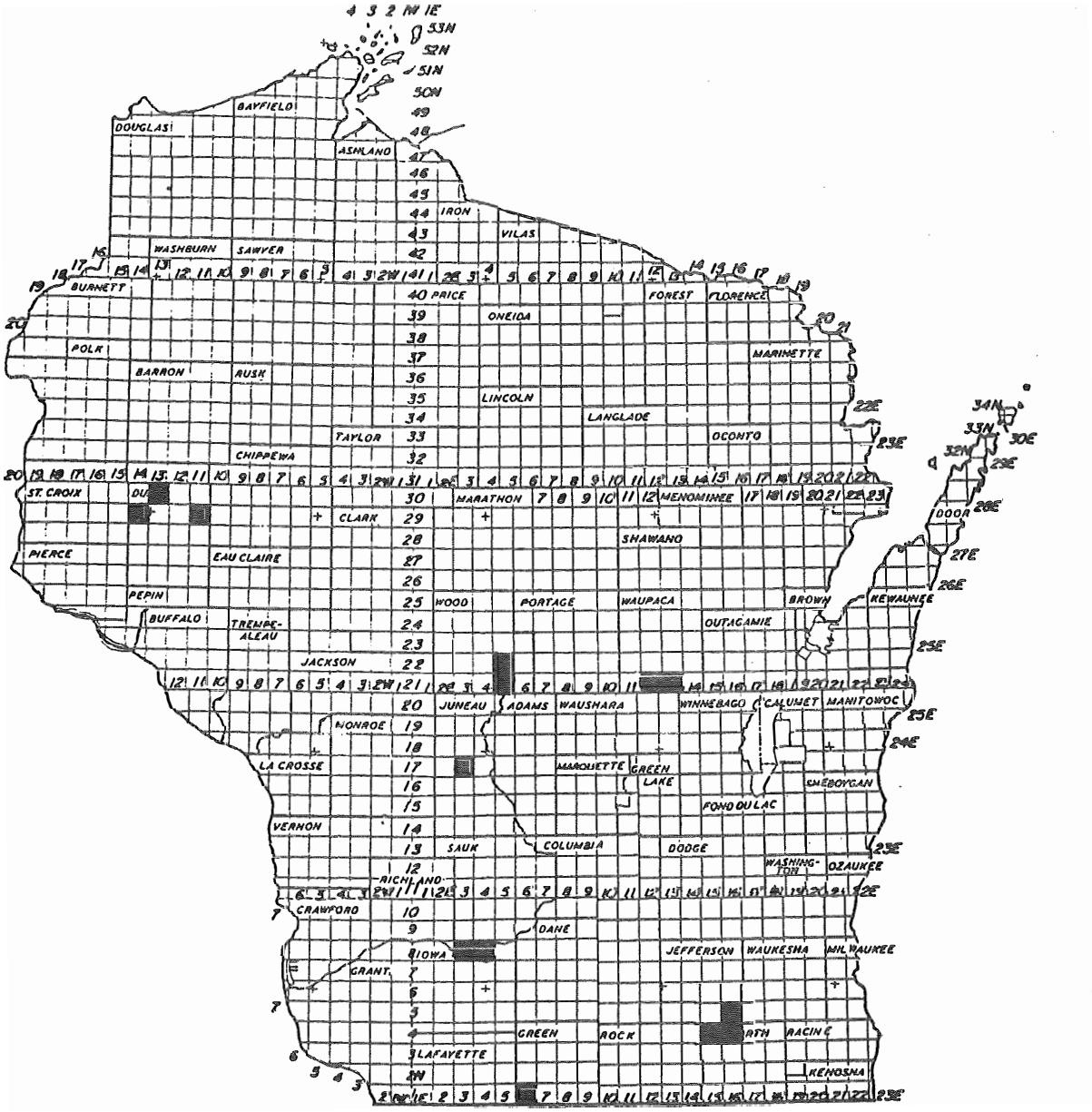


Figure 11. Township locations of Red Pine Pocket Mortality that have been investigated - 1986.

**White Pine Needlecast** - Scirrhia acicola (Dern.) Siggers

This disease was first observed in Wisconsin on white pine in 1984 in four counties. In 1986, another observation was made in Jackson County (Figure 12). The new location is just north of Black River Falls, (T21N, R4W, S2, SE¼ SW¼, Sec 2). At this location, approximately 15, 50-year-old trees along a driveway and polesize understory had heavy defoliation.

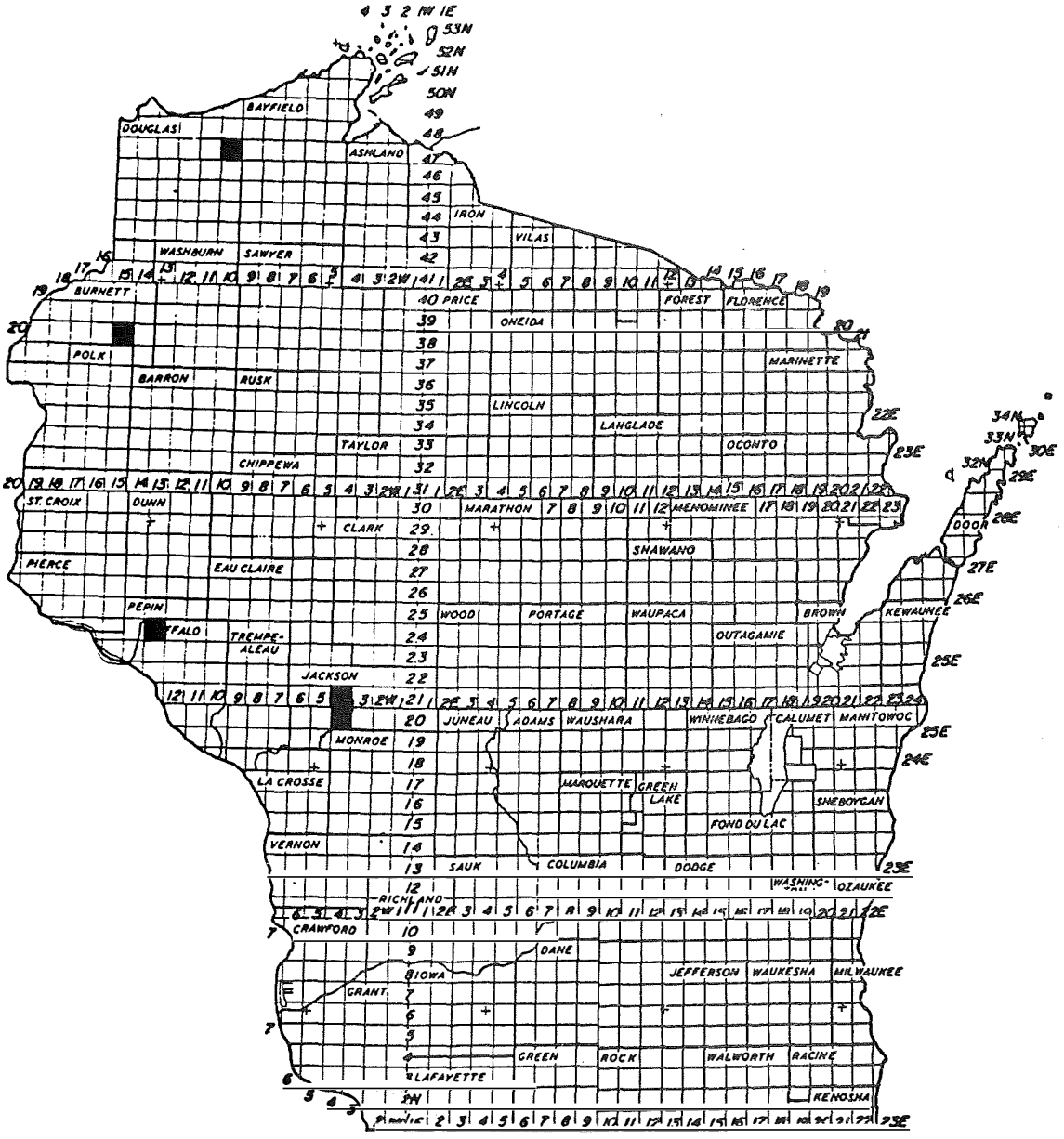


Figure 12. Township locations of White Pine Needlecast caused by Scirrhia acicola - 1986

**White Pine Needle Blight** - Atmospheric Gases

Reports of white pine needle blight were made by Christmas tree growers in Waushara County near Redgranite the first two weeks in July.

**Gall Rust** - Cronartium quercuum (Berk.) Miyabe ex Shirai F. sp. banksianae Brudsall & Snow or Endocronartium harknessii (J. P. Moore) Y. Hiratsuka.

In Wood County, east of Wisconsin Rapids, Scotch pine Christmas trees were heavily infected in at least three plantations. Economic damage occurred on approximately 18% of Belgian variety Scotch pine while adjacent French green were not infected. The grower cut and destroyed the galled trees. Identification of the gall rust will be made in 1987. This disease was also present in the jack pine seed orchard at Wisconsin Rapids.

**Jack Pine Budworm** - Choristoneura pinus (Rohwer)

The outbreak that began in the northwestern counties in 1978 and peaked in 1984 at about 270,000 acres of defoliation, declined to non-economic levels this year. No significant defoliation was observed anywhere in Wisconsin.

Phenological note:

May 28 -2nd instar larvae are feeding on new shoots and pollen cones in Burnett, Polk and Jackson counties.

**Pine Tussock Moth** - Dasychira pinicola (Dyar)

Populationss continued at very low levels in the old outbreak areas of Douglas and Bayfield counties.

**European Pine Sawfly** - Neodiprion sertifer (Geoffroy)

The level of defoliation and complaints remained about the same as in 1985. Occasional red pine plantations and Scotch pine Christmas tree plantations were defoliated in Jefferson and Waukesha counties.

**Red Pine Sawfly** - Neodiprion nanulus nanulus Schedl

The numbers of colonies increased along the lower Wisconsin river in southern Sauk and northern Iowa counties. No serious defoliation occurred but colonies were common in sapling to pole sized red pine plantations.

**Redheaded Pine Sawfly** - Neodiprion lecontei (Fitch)

The outbreak in Forest and Langlade counties collapsed. Only 3 colonies were found on 50 acres of previously infested red pine plantations in Forest County. Light infestations occurred in Burnett, Washburn and Sawyer counties where a few jack pine and red pine plantations were sprayed with Malathion.

**Introduced Pine Sawfly** - Diprion similis (Hartig)

No significant change occurred in the light populations throughout Wisconsin. The normal numbers of reports of colonies and light defoliation were received.

**Red Pine Shoot Moth** - Dioryctria resinosella Mutuura

Populations continued at low levels in the hazard zone (Figure 13) in the central counties.

Figure 13. Red Pine Shoot Moth hazard zone in Wisconsin

**Eastern Pine Shoot Borer** - Eucosma gloriola Heinrich

The numbers of damaged shoots on Scotch pine Christmas trees remained stable in some areas and increased substantially in other areas of the central counties. Some damaged shoots were found in which larvae had made an initial attack but had not completed feeding. Light damage occurred in a Scotch pine plantation in Washburn County.

**Saratoga Spittlebug** - Aphrophora saratogensis (Fitch)

Populations increased markedly in the northwestern counties.

About 300 acres of 8 to 15-year-old red pine plantations were damaged in Douglas and Bayfield counties (T45N, R9W, S3 and T46N, R11W, S33 and 34).

Phenological notes:

July 1 - Nymphs up to 3rd instar are present in Oneida County.

**Pine Bark Adelgid** Pineus strobi (Hartig)

A heavy infestation occurred in white pine seedlings at the Griffith State Nursery in Wood County during the second and third week of May. Ladybird beetles were present and reduced the potential for any tree damage.

**Pine Needle Scale** - Chionaspis pinifoliae (Fitch)

Scale populations rose dramatically in some southern Wisconsin white and Scotch pine plantations. Some young white pines in Iowa County had abundant scales. Some Scotch pine in Dane County appeared almost white with scales.

**White Pine Aphid** - Cinara strobi (Fitch)

Colonies of aphids were numerous in Oneida County and usually accompanied by sooty mold. Reports of heavy infestations were received from LaCrosse and Rock counties.

**Pine Root Collar Weevil** - Hylobius radicis (Buchanan)

Damage to plantations, windbreaks and Christmas trees continued to increase statewide. In the central sands counties, untreated Scotch pine Christmas trees faded in increasing numbers; nearby red pine were also fading in increasing numbers in late summer.

Elsewhere, red pine mortality occurred in Oconto, Burnett, (T40N, R15W, S9, SESE), Polk (T36N, R20W, S16) and Washburn (T39N, R12W, S3; T39N, R13W; T40N, R13W) counties.

Phenological note:

July 6 - Larvae were moving into the soil and pupating in Waushara County.

**Pine Root Tip Weevil** - Hylobius rhizophagus Millers, Benjamin & Warner

Damage to red pine increased throughout the northwestern counties with damage heaviest in a roadside plantation in Washburn County where 10-year-old red pine was growing on a cut bank adjacent to natural jack pine (T38N, R13W, S4).

**White Pine Weevil** - Pissodes strobi (Peck)

Populations remained stable or declined slightly in the northwestern counties. Some damage to red pine occurred in southeastern Douglas and southwestern Bayfield counties. A significant decline occurred in Clark and Jackson counties. Heavy infestations were found in sapling white pine in Oneida County.

Phenological note:

April 28 - Adults are feeding on white pine terminals near Milston in Jackson County.

July 1 - Larvae are making chip cocoons.

**Pine Engraver** - Ips pini (Say)

After two consecutive warm dry springs, early-season beetle populations were noticeably higher in many locations. Standing red pine and red pine slash were attacked in Dunn County. Jack pine pulpwood was attacked in Jackson County. Red pines stressed by high water in Polk County (T36N, R20W) were heavily damaged.

Phenological note:

May 7 - Males are building nuptial chambers and females are ovipositing eggs in Dunn County.

June 18 - All life stages including callow adults are present in pine pulpwood in Jackson County.

**Red Turpentine Beetle** - Dendroctonus valens LeConte

Stressed pines were attacked with increasing frequency in many locations. Fire-injured red and white pines were attacked in Vilas County. Suppressed and lightning-struck pole sized red pines were attacked in Iowa County.

**White Grubs** - Phyllophaga sp.

Damage to conifer roots increased markedly. Large numbers of grubs were observed in several northern Wisconsin tree planting sites. Large numbers of June beetles were observed in Burnett County and in Washburn County where beetles defoliated aspen and willow. Wisconsin Department of Agriculture reported generally increased numbers of June beetles in light traps over much of Wisconsin. About 75% of the seedlings in a new red and white pine planting in Columbia County were killed. In La Crosse County white grubs killed 10 to 15% of a newly planted 3 acre white pine seed orchard and 25% of a 3 yr old experimental larch planting. Reports of damage to balsam fir and Frasier fir Christmas trees were received from Waushara County.

White pine 2 - 0 seedlings were damaged in Rock County.

**Plains Pocket Gopher** - Geomys bursarius

Most red pine plantations under 10 years old suffered some mortality in Douglas and Bayfield counties. Mortality generally was 1 - 2% but a few plantings had almost 5%.

BLACK WALNUT

**Plantation Black Walnut Canker** - Fusarium sporotrichioides Sherb.

A perennial canker on walnut has been observed in plantations in Vernon, Crawford, Richland, and Grant counties. Field studies conducted in 1984 and 1985 showed that cankers formed on pruning wounds from May through October in southwestern Wisconsin (see Forest Pest Conditions in Wisconsin Annual Report 1985).

In 1986, the field study was expanded to determine the incidence of cankers on trees pruned in February through May. Forty trees were chosen for the pruning study, and four branches per tree were pruned with alcohol sterilized pruning sheers. Pruning was done on four dates; February 25, March 21, April 19, and May 21. Observations were made on December 3, 1986, and Table 2 lists the number of pruning wounds with various symptoms. The site was visited once a month, and as of December 3, 1986, no cankers were observed on any of the pruning wounds, but 11 wounds had dead bark and sunken tissue around them. Callus formation was observed on 140 of the pruning wounds and on 20 pruning wounds, no callus had formed or none could be seen.

TABLE 2. Number of pruning wounds showing various symptoms, on walnuts pruned on four dates.

| | | Number of Pruning Wounds | | |
|---|---|---|---|---|
| Pruning date | Branches pruned | Callus formation | No callus formation | Dead bark and sunken tissue around pruning wound |
| 2/25/86 | 40 | 38 | 1 | 1 |
| 3/20/86 | 40 | 38 | 1 | 1 |
| 4/19/86 | 40 | 28 | 6 | 6 |
| 5/21/88 | 40 | 36 | 1 | 3 |
| Total | 160 | 140 | 9 | 11 |

Two areas were chosen for a study of the effectiveness of sanitation or removal of infected trees on reducing future canker incidence. One site is on the Douglas Hallock Memorial Forest in Grant County, and the other is a privately owned plantation in Vernon County. Plans are for all the infected trees to be removed during 1987 from the two sites, and to monitor canker incidence.

**Walnut Caterpillar** - Datana integerrima Grote & Robinson

Populations were very low for the second consecutive year. No colonies were reported.

**A Shoot Borer** - Acrobasis juglanivorella Nuenzig

This newly named shoot borer continued at low densities in the southern counties this year. A few larvae were collected from the DNR black walnut seed orchard at Wyalusing State Park in Grant County.

Phenological note:

June 6 - Larvae full grown in Grant County.

**Pecan Leaf Casebearer** - Acrobasis juglandis (LeBaron)

Numbers continued at very low levels. A few cases were noticed on black walnut foliage in June and July.

MISCELLANEOUS SPECIES

**Herbicide Injury** - "COMMAND" herbicide (FMC Corp.)

"COMMAND" herbicide was sprayed on or around May 10, 1986, in soybean fields scattered in Turtle Township, (T1N, R13E, S33 and 34), Rock County. This herbicide is known to move by volatilization and cause a bleaching effect on foliage of vegetation in contact with the vapors. Two weeks after the herbicide application, the DNR Rock County forester answered complaints from land owners, and collected vegetation specimens within a ½ mile of an area sprayed with "COMMAND." The following observations were made:

1. species with bleached, white tissue and interveinal chlorosis - ash, cherry, mulberry, spirea;

2. species with chlorotic spots and interveinal chlorosis-elm, white pine, spruce, yew, oak, basswood, Russian olive, crabapple, potentilla, blackberries and raspberries;

3. species seemingly unaffected - hickory, birch, maple, honeylocust, juniper, buckthorn, lilac.

Samples were examined for insect and disease damage at the DNR Forest Pest Laboratory and none was found.

The site was reexamined on July 16, 1986, and the following observations were made:

1. An ash tree at the residence of John Dorr, Beloit, Wisconsin, had leaves on all sides that were yellow or white. The youngest leaves were most severely affected. Very little re-greening appears to be occuring.

2. Basswood tree at the residence of Ed and Carol McCabe, Beloit, Wisconsin, had chlorotic and white leaves that were scattered throughout the crown.

3. White oaks along County Highway P, east of the Beloit Airport had chlorotic and white leaves that were scattered throughout the crowns.

4. Chlorosis and whitening of foliage on trees and shrubs in a woodlot on the southeast edge of the Beloit Airport.

All information concerning observations, photographs and samples was given to the Agricultural Resource Management Division of the Wisconsin Department of Agriculture Trade and Consumer Protection.

**Gypsy Moth** - Lymantria dispar (L.)

For the second consecutive year no moths were caught in old infestations near Oconomowoc, Hubertus and in Monona. These infestations are considered eradicated.

The number of adult males caught in traps increased from 13 in 1985 to 33 this year. The following table of adult male moth catches was provided by Wisconsin Department of Agriculture.

Table 3. Number of adult male gypsy moths caught in traps in Wisconsin in 1986.

| COUNTY | NO. OF ADULT MALES |
|---|---|
| Brown | 1 |
| Door | 2 |
| Kenosha | 1 |
| Marinette | 2 |
| Milwaukee | 22 |
| Racine | 2 |
| Washington | 1 |
| Waukesha | 2 |
| Total | 33 |

**Fall Webworm** - Hyphantria cunea (Drury)

The numbers of webs increased in much of southern Wisconsin. Occasional webs could be seen in many other areas. The number of webs decreased to very low levels in the northwestern counties.

Phenological note:

July 9 - Larvae are one-half inch long in Dane County.

July 16 - Larvae are in the 3rd instar in Vilas County.

**European Fruit Lecanium** - Parthenolecanium corni (Bouche)

Pockets of heavy infestations were reported on sugar maples in Forest and Florence counties.

A heavy infestation was reported on ornamental sugar maple and white ash in Oneida County.

Heavy populations were found on sugar maple and basswood in Iron County.

**A Bagworm** - Fumaria costa (Fall)

The small infestation near Hixton in Jackson County declined significantly. A new population was discovered in a white pine plantation in Washburn County (T38N, R13W, S11, SWSW).

**Swamp Hardwood Mortality** - Rising ground-water level

Foresters in eastern Wisconsin in the Green Bay area, have observed decline and mortality of swamp hardwoods. The surface and ground-water levels have been high the past two years.

**Ice Storm Damage**

In early February, an ice storm occurred in southeastern Wisconsin, causing damage to susceptible species. Broken branches and tops were common on willow, box elder, white birch, and aspen. Damaged trees were scattered throughout southeastern Wisconsin. Urban trees in the city of West Bend were severely damaged.

CHRISTMAS TREES

**Cyclaneusma Needlecast** - Cyclaneusma minus (Butin) DiCosmo, Peredo and Minter

In 1985, a study was initiated by the U. S. Forest Service, North Central Forest Experiment Station in Waushara County. The purpose was to determine the effectiveness of various concentrations and application timings of the fungicide Bravo 500 (chlorothalonil) in controlling Cyclaneusma needlecast on Scotch pine. Because of severe winter injury to the test trees in the winter of 1985-86, data could not be collected on the incidence or severity of disease. Isolations could not be made accurately because of the mortality of needles.

In 1986, a new study was established with the same purpose as the previous study. Three concentrations of Bravo 500, and one concentration of each of the following: Dithane M-45, Benlate, and Bravo W-75 were applied in June, August, and October. All but the control plot will also be sprayed in the spring of 1987. In 1987, samples of the 1986 needles will be collected for laboratory isolations and the trees will be rated for winter injury.

**Winter Injury**

Severe winter injury symptoms were observed on Scotch pine Christmas trees in Waushara County. Many of the injured trees had been sprayed aerially in 1985 with the fungicide Bravo 500 (chlorothalonil), Fermenta Plant Protection Company, as part of a study on the effectiveness of Bravo 500 in controlling Cyclaneusma needlecast. The U.S. Forest Service, North Central Forest Experiment Station together with Christmas tree growers, rated the trees for winter injury in April and found a highly significant relationship between the total number of pints of Bravo 500 applied per treatment and the mean winter injury rating per treatment. This apparent enhancement of winter injury associated with the use of Bravo 500 may be because several of the treatments had fungicide rates higher than are currently labelled for conifers. Also, 5 gallons of water per acre was used in the study (based on the chemical company's test protocol) instead of the 10 to 50 gallons specified for aerial applications on the 1985 label.

The Fermenta Plant Protection Company, Painesville, Ohio decided to further study the association between Bravo 500 and winter injury, and control of Cyclaneusma needlecast; aerial treatments were applied again in 1986.

**Balsam Fir Needlecast** - Isthmiella sp.

A balsam fir sample was received from a Christmas Tree Farm near Antigo, Wisconsin. The sample was infected with the needlecast fungus Isthmiella. Infection in the plantation was moderate.

**Spruce Needle Rust** - Chrysomyxa weirii Jacks

Telia were observed in mid-May on one-year-old needles on blue spruce in a Christmas tree plantation in Marathon County, north-central Wisconsin. Infection in the plantation was very light. No control was recommended. There is no known alternate host for this rust.

**White Pine Stem and Branch Deformity** - Unknown

White pine Christmas trees with constrictions on the stem at the ground-line and on the branches were observed in Marathon, and Eau Claire counties. The constrictions may be caused by splits occurring in the bark and cambium when the seedlings and branches are weighted down by snow. When the trees begin to grow in the spring, the stem swells abnormally just above the constricted area. Affected branches and seedlings are killed. Some of the damaged tissue had fungal fruiting bodies present and attempts will be made to identify the fungi present. A canker disease is suspected as playing a role in this malady.

**Fraser Fir Needlecast** - Rhizosphaera pini (Cda.) Maubl.

Five to seven-year-old Fraser fir Christmas trees had casting of their one-year-old needles at a Christmas tree plantation in Oconto County, northeastern Wisconsin. Casting was heavy on the bottom half of the trees, and number of infected trees was greatest on the north side of a slope. Infection was scattered in other areas of the plantation. The grower plans to spray in spring, 1987 with a protective fungicide.

**Fraser Fir Mortality** - Unknown

In August, a Christmas tree grower in central Wisconsin observed severe mortality of Fraser fir. The trees had been planted in the spring of 1985, and looked healthy on July 20, 1986. By mid-August, heavy mortality was observed in one field, while all other areas planted had good survival. Soil and seedling samples were collected and sent to the University of Wisconsin, Plant Pathology Department for analysis for Phytopthora fungi. Phytopthora cactorum was the only species of Phytopthora isolated from the soil. This species is common in forest and field soil and is not associated with conifer root rot. No other root or stem diseases were isolated. The site will be visited in 1987.

NURSERY

**White Pine Root Rot** - Unknown

See Appendix C for results of a greenhouse and field study conducted to determine the relationship between root rot severity and seedling survival.

Mortality of white pine seedlings from root rot of unknown origin was severe at Wilson State Nursery, Boscobel, in 1985. To eliminate the possibility of root rotted stock being shipped, a sorting process was set up at the Wilson Nursery during the lifting and shipping season in April, 1986. Every white pine seedling was examined for the presence of rotted roots and infected seedlings were culled. Out of an inventory of 840,000 seedlings, approximately 68% or 571,000 were culled because of root rot.

In surveys conducted at the Wilson Nursery and Griffith State Nursery, Wisconsin Rapids, in September, 1986, root rot was again causing significant mortality in the 3-0 and transplants. Both nurseries will sort the white pine stock before shipping in April, 1987, to eliminate root rotted seedlings. The survey also showed that the 2-0 white pine at Wilson and Griffith had an extremely low incidence of root rot.

At Wilson Nursery, cultural controls were attempted in the fall of 1985. White pine was planted in sections of the nursery where it had not been planted for many years. This was to avoid areas where build-up of the pathogen may have occurred. Red pine was planted in the outer rows of each white pine section, as disease incidence is usually highest in this area, and red pine is not affected by the unknown pathogen.

The emphasis in 1987 will be on surveys. The three state nurseries will be surveyed for incidence and severity of white pine root rot. Also, two surveys to determine the survival of out-planted sorted and bed-run stock will be conducted.

Appendix A

RED PINE SEED AND CONE INSECTS

By David J. Hall[1]

A 1983 Seed and Cone Insect Survey of the red pine seed orchard at Avoca conducted jointly with USFS S&PF revealed that 27.9% of the cones were attacked by insects and that 20.2% were attacked by the eastern pine seedworm, Cydia toreuta (Grote). Other insects found in the survey were the red pine cone borer, Eucosma monitorana Heinrich and the webbing coneworm, Dioryctria disclusa Heinrich. Damage by a seed resin midge, Asynapta hopkinski Felt was detected in the 1985 test and adults of the shield back seed bug, Tetrya bipunctata (H-S) were frequently observed.

In 1984 and 1985 DNR personnel cooperated with USFS - S&PF and University of Wisconsin to test the ability of both liquid and granular formulations of carbofuran to protect the cones from three species of insects.

In 1984 a single rate of 0.8 oz. AI/inch dbh of each formulation was tested. In 1985 rates of 9.8, 0.6 and 0.4 oz. were tested. The liquid formulation gave consistantly better control than the granular formulation. The efficiency was much greater for all rates and both formulations in 1984 probably due to timing of application. In both years treatments substantially reduced insect damage. Virtually no viable seed was produced in untreated trees. Phytotoxicity became apparent on the older needles during August; the effect was most evident from the liquid formulation at the higher rate. The results of the 1984 test will be published in The Northern Journal of Applied Forestry.

In 1986, about 7 acres of the seed orchard was treated with 0.6 oz. AI/acre of the liquid formulation. It was evident at harvest time that the treatment increased the number of unattacked cones by perhaps as much as ten times or more. Seed extraction yielded 8 oz. of seed per bushel of cones from the treated areas and 4.6 oz. per bushel of cones from the untreated area.

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Appendix B

# A HISTORY OF THE INSECT AND DISEASE PESTS OF SUGAR MAPLE IN WISCONSIN

By Jane Cummings[1]

Approximately 15.4 million acres (44% of Wisconsin's land area) is forested (Raile, 1983). Commercial forest land occupies 14.8 million acres (96% of the forest land). Areas of forest type are: maple-birch, 4.0 million acres; aspen, 3.3 million acres; oak-hickory, 2.9 million acres; and conifer, 2.6 million acres. Sixty-one percent of the maple-birch type is in the poletimber, sapling and seedling stage (less than 11" dbh). Sixty-nine percent of the maple-birch type is in northern Wisconsin. Maple-birch stands are increasing their dominance in Wisconsin's forests. Since 1968, the number of acres has increased by 475,000 (Smith, 1986). This gain in the maple-birch type is primarily a result of maturing aspen and oak-hickory succeeding to northern hardwoods.

In 1957, the first recorded observations were made of significant sugar maple mortality. The condition referred to as maple blight was characterized by sudden deterioration of the crowns and death of sugar maple trees of all sizes. Maple blight occurred in areas of various sizes scattered over 10,000 acres in Florence County in northeastern Wisconsin. After four years, approximately 1,000 acres of sugar maple had died. In 1958, a cooperative study between the Departments of Entomology and Plant Pathology of the University of Wisconsin, the Wisconsin Department of Natural Resources, and the Lake States Forest Experiment Station of the U.S. Forest Service, was initiated to investigate the entomological, pathological, distributional and ecological factors associated with maple blight (Giese et. al. 1964).

After four years of study, four stages of symptom development were characterized: branch dieback, foliage chlorosis and wilt, epicormic sprouting, and tree mortality. In some areas, all four stages were present and occasionally, only one was observed. The entomological study revealed that in stands where maple blight was present, severe dofoliation occurred in 1955, '56, and '57, by two leaf rollers, Sparganothus acerivorana, and Acleris chalybeana, and the maple webworm Tetralopha asperatella. S. acerivorana started feeding in early June, while A. chalybeana appeared in early to mid June. The presence of the leaf-rollers contributed to the successful population of maple webworm because of the webworm's egg laying habits. Eggs of the webworm are laid on the surface at the edge of a roll on partially rolled leaves. The study showed that a majority of the webworm's eggs were laid on leaves rolled by A. chalybeana. Feeding by the webworm began in July and continued through September. If sugar maple is severely defoliated during a critical period (mid-June through August), refoliation is induced and food reserves stored as starch in the roots are used (Wargo et. al., 1972). The new leaves do not have enough time to replace the starch or food reserves necessary for maintaining living tissues until the spring growth flush. Twig and branch dieback may occur from winter dessication or a lack of food reserves. The next year after defoliation, the leaves may be chlorotic, small, and clumped.

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A contributing factor in the mortality was infection by the root rotting fungus Armillaria mellea. Stumps of defoliated trees were attacked more frequently than stumps of nondefoliated trees. Also, saplings continued to die in pockets for at least 3 years after defoliation which suggests the presence of root rot.

After the outbreak of the maple blight associated insects, S. acerivorana, A. chalybeana, and T. asperatella, surveys were conducted annually in northern Wisconsin for the two leaf rollers and the maple webworm (Forest Pest Conditions in WI, 1958-1985). Moderate populations of the insects caused light defoliation throughout the northern hardwood type in 1961 and '62. In 1963, light defoliation on approximately 2,000 acres occurred in Menominee County. In 1964, only scattered light defoliation was observed. Populations remained low until 1983, when heavy defoliation of sugar maple by the webworm was observed in north-central Wisconsin. In 1984, heavy to severe defoliation occurred on several thousand acres in north-central Wisconsin.

Another maple defoliator, maple trumpet skeletonizer, Epinotia aceriella (Clem.), was first recorded in Wisconsin in 1958 (For. Pest Con.in WI, 1958). Areas of defoliation have varied over the past 25 years. Notable defoliation was not reported until 1979 when moderate defoliation was observed on 200 acres in Langlade County, in north-central Wisconsin. The infestation increased in 1980 and skeletonized leaves were evident on most sugar maples in the northern half of the state. In 1981, heavy defoliation increased and occurred over 100,000 acres in north-central Wisconsin. A significant decrease in the population occurred in 1982 and '83.

In 1961, an outbreak of another sugar maple defoliator, the orange humped maple worm, Symmerista leucitys Franclemont, occurred throughout northern Wisconsin (For. Pest Con.in WI, 1961). Heavy defoliation was observed in late summer on approximately 10,000 acres in Vilas County and westward to Douglas County. Permanent plots were established in Vilas County in 1961 to determine incidence of mortality and one year later, sugar maple saplings in the plots had died from complete defoliation and infection by Armillaria root rot. In 1962, populations of the orange humped maple worm had sharply declined in all areas. Dipterous larval parasites played a significant role in the population decline. Significant defoliation was not reported again until 1970 when 100 acres of sugar maple in Polk County in western Wisconsin were completely defoliated. The population remained low until 1981 when severe defoliation was observed on approximately 3,000 acres in north-central Wisconsin. The population collapsed in 1982.

Since 1952, a spring defoliator, the forest tent caterpillar, Malacosoma disstria Hubner, has defoliated aspen and sugar maple in northern Wisconsin (For. Pest Con. in WI, 1952-1985). A peak occurred in 1954 when 8,000,000 acres were defoliated, primarily in northwestern Wisconsin. Populations remained high until 1959, when the infestation in northwestern Wisconsin decreased, but defoliation remained heavy in Langlade County in northeastern Wisconsin. An egg mass survey was conducted annually to predict the expected populations. In 1960, the population crashed and larvae were not observed until 1975, when small infestations were found in Jackson County in western Wisconsin. A small outbreak in Douglas County was detected in 1977 where 5,000 acres were defoliated, only to be followed by another population crash in 1978.

Another outbreak in the northern counties peaked in 1981 when 1.4 million acres were defoliated. Decline and mortality of hardwoods that had been defoliated for several consecutive years were observed. There has been a slow decrease in the population since 1981 and no defoliation was observed in 1985.

In 1984, the first recorded outbreak of the Bruce Spanworm Operophtera bruceata (Hulst) was observed when 200 acres of sugar maple were defoliated in Menominee County (For. Pest Con. in WI, 1984). The infestation erupted in 1985 and eight counties in northeastern Wisconsin had scattered defoliation. Pockets of heavy defoliation occurred in Menominee and Forest counties. Adult populations were monitored in the fall of 1985 and were extremely high. In 1986, infestations in Menominee County decreased, but over 100,000 acres were defoliated in Florence, Langlade, and Marathon counties.

Sugar maple in Wisconsin has been under attack from many insect defoliators. Wargo and Houston, 1974, have shown that defoliation of sugar maple can result in infection of roots by Armillaria which can lead to mortality. They have observed that infection is more prevalent on trees defoliated in June or July and on trees defoliated for two consecutive years, a combination that has occurred several times in Wisconsin since 1953. Other defoliators such as the forest tent caterpillar have caused 70% reduction in basal area growth of aspen during the first year of defoliation and 90% reduction during the second year (Duncan et. al. 1956). Insect defoliators have played an important role in the decline and mortality of sugar maple and should be surveyed for when determining the cause of current sugar maple mortality.

Weather extremes have also been reported as causing mortaliy of sugar maple. In 1982, seedling and pole-sized sugar maple leafed out and wilted early in June in isolated areas in Ashland and Langlade counties in northern Wisconsin (For. Pest Con. in WI, 1982). Up to 90% of all sapling maples in some areas were killed at the snowline. The stem below the snowline was alive and produced new sprouts. Extremely cold temperatures were diagnosed as the cause and the average minimum temperature for the month of January in the affected area was -12.7 F (NOAA, 1982). The coldest temperature recorded was -39F, and the temperature was in the -30's for five days.

In 1976, Wisconsin experienced a drought where the average annual precipitation departed from normal -11.23" in northern Wisconsin (NOOA, 1987). The drought, in combination with other stresses and pathogens caused scattered mortality of hardwoods in succeeding years throughout Wisconsin.

On July 3, 1983, a frontal system produced a long line of strong thunderstorms and downburst winds which created a path of damaged timber through northwestern Wisconsin. Approximately 10,000 acres of northern hardwoods, of which sugar maple is a major component, were destroyed in that storm.

Sapstreak disease caused by the fungus Ceratocystis coerulescens (Munch) Bakshi, was first observed on the Nicolet National Forest in 1971. It was not found again until 1984 when it was isolated from sugar maple in Menominee County. Affected trees have dwarfed foliage on all or portions of the crown, and twig and branch dieback. Surveys are planned to determine incidence of sapstreak in Menominee County where 122,000 acres of high quality sugar maple grows.

Other forest pests affecting Wisconsin's sugar maples include the decay fungi Oxyporus populinus, Innonotus glomeratus, Phellinus igniarius, and Coryolus versicolor. Cankers commonly observed are Eutypella parasitica, and Nectria galligina. The sugar maple borer, Glycobius speciosus is also present.

Sugar maple decline has been significant in urban areas in Wisconsin. Sugar maples along city streets and around homes frequently lose their vigor and die over a period of several years. Suspect maple may show early fall coloration on one to several branches, and affected branches usually have smaller leaves. Often associated with these declining trees is a collar rot and basal canker. The collar rot symptoms are bark discoloration in patches, including watersoaking, and exudates from cracks or openings. Basal cankers are under areas of loose bark and are irregular in shape. The cambium and wood associated with cankers may be tan, dark brown, or red (Worf et. al., 1981). Two fungi have been isolated; Phytophthora citricola from the collar rot, and Fusarium from the basal canker. Reports of urban maple decline in Wisconsin have been recorded annually since 1965 (For. Pest Con. in WI, 1965-1985).

Two foliage diseases occasionally affecting sugar maple are anthracnose, Gloeosporium apocryptum, and tar spot, Rhytisma spp. Although these have not caused significant injury, they should be considered as part of the multiple stresses that can contribute to mortality.

Two reports of damage to sugar maple in Wisconsin by air pollutants have been recorded (For. Pest Con. in WI, 1972-1984). In both instances, sulfuric acid mist was determined to be the cause of interveinal necrosis and vegetation damage was confined to an area within 1000 feet of the Wausua Paper Mill in Brokaw, Wisconsin.

Because of the many pest problems affecting sugar maple, separating the effects of any one would be a complex problem. Any current surveys to determine the cause of decline and mortality of sugar maple in Wisconsin would have to consider the multiple biotic and abiotic factors affecting tree health.

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Appendix C

EFFECT OF ROOT ROT ON SURVIVAL OF WHITE PINE SEEDLINGS IN THE GREENHOUSE AND FIELD.

By Jane Cummings[1] and Mike Drilias[2]

GREENHOUSE STUDY

White pine 2-0 seedlings were lifted in the fall of 1985 and stored at 40 C for 2.5 months. Seedlings were divided into one of four root health classes (RHC); RHC 0, 80-100% of the total root length with short roots; RHC 1, 50-79%; RHC 2, 20-49%; RHC 3, 0-19%. Fifty seedlings in each category were planted in a sandy loam soil in the greenhouse.

These categories were chosen based on observations that the first observable symptom of root rot was the lack of short roots, therefore trees in RHC 3 have the most root rot. The soil was kept moist, and no nutrients were applied. Once a week, for nine weeks, data was collected on the incidence of mortality, and the number of seedlings in four crown vigor classes.

Table 1. Description of crown symptoms on white pine in four crown vigor classes.

| Crown Vigor Class (CVC) | Description |
|---|---|
| 1 | Foliage green, some needle tips chlorotic |
| 2 | Needles with chlorotic tips throughout the crown |
| 3 | Entire crown chlorotic, incipient wilt |
| 4 | Plant completely wilted or dead |

After nine weeks, mortality was highest in the RHC 3 (Figure 14). The percent of seedlings dead in RHC 0, 1, and 2 varied only 6%. The fair to poor survival of seedlings with relatively good root systems could mean several things. The conditions in the greenhouse for survival may have been poor (too hot, low nutrients, etc.), or the root rot may progress in seedlings even though 80-100 % of their root systems are apparently disease free.

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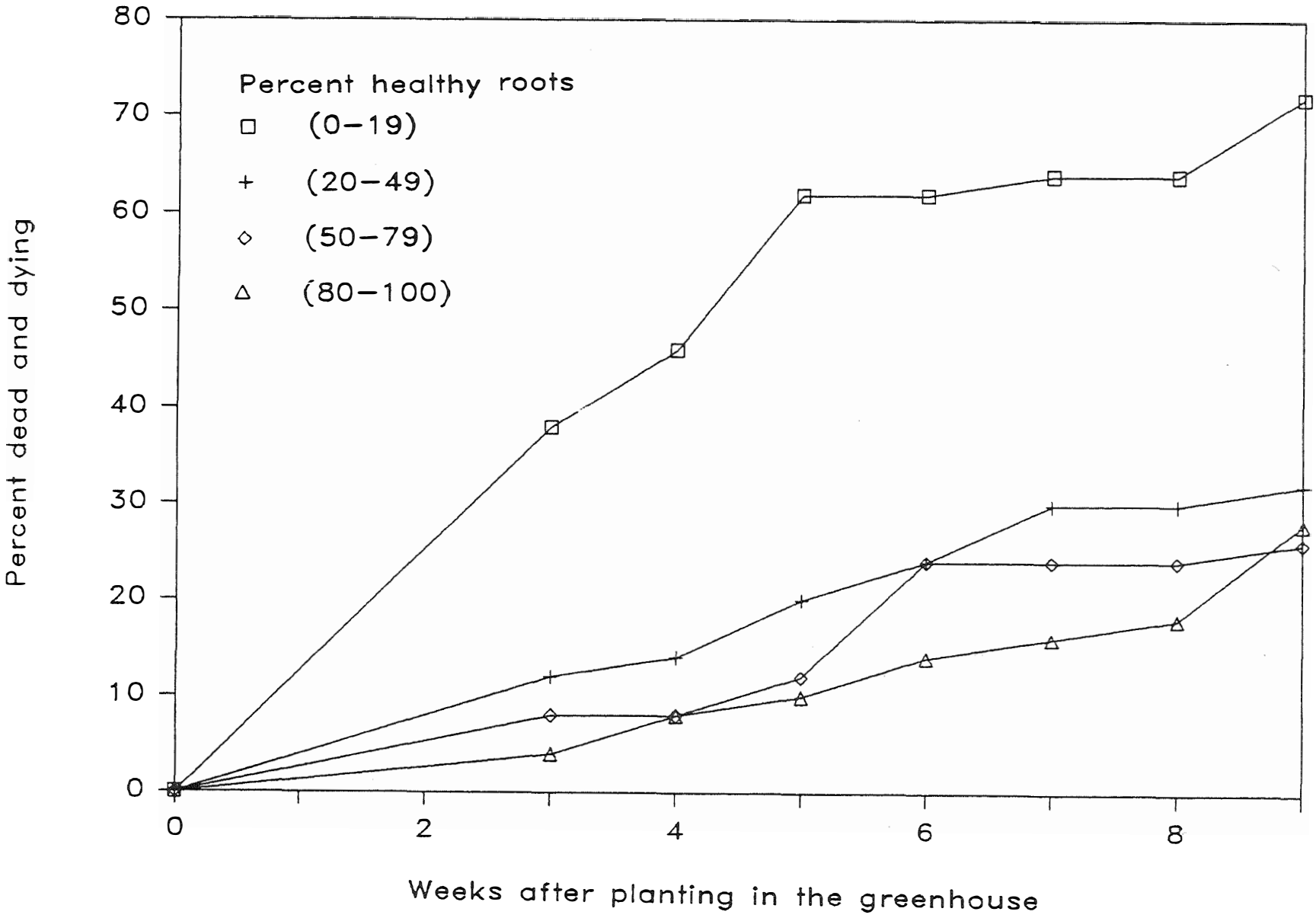


Figure 14. Accumulative percent of dead and dying 2-0 white pine seedlings with various percentages of healthy roots.

Because of the results showing no significant differences in survival between RHC 0, 1, and 2, a field study was planned to study the same question of the effect of RHC on seedling survival.

When the greenhouse experiment was terminated, all the trees were dug up and examined. It was noted that upon final root examination, there was not a correlation between the crown symptoms (CVC), and the root rot (RHC), of seedlings unless the seedlings were dead (CVC IV). Therefore, in this experiment, crown symptoms did not appear to be a good indication of root health. This reaffirms what has been observed in the nursery where seedlings with green crowns may have moderate to severe root rot.

FIELD STUDY

On April 10, 1986, white pine 3-0 seedlings were lifted from the Wilson Nursery and sorted into four root health classes (RHC) (see categories above). The objectives were to determine if the observable root health was related to field survival. One hundred and fifty seedlings were sorted into each category and planted in a sandy field behind the nursery in a randomized design of 15 rows of 40 seedlings each. Observations on crown symptoms and incidence of mortality were made once a month for three months. At the last reading, July 17, seedings in all root health classes had poor survival (Figure 15). Even the seedlings with 80-100% of their root length with short roots had 51.0% mortality. The poor survival may have been a combination of root rot, a long period without rain in May and June, and the extremely dry site. The presence of root rot appears to affect the survival, but relating this information to the prediction of field survival of sorted nursery stock is difficult because of the unexplainable high mortality in all categories.

In 1987, another larger field study on a better site will be done to look at the survival of bed-run or nonsorted stock and sorted white pine seedlings. The sorted white pine will go through a process of examination for root rot and the apparently healthy seedlings along with the culls or root rotted seedlings will be planted.

White pine sold to the general public will also be surveyed one to two months after planting.

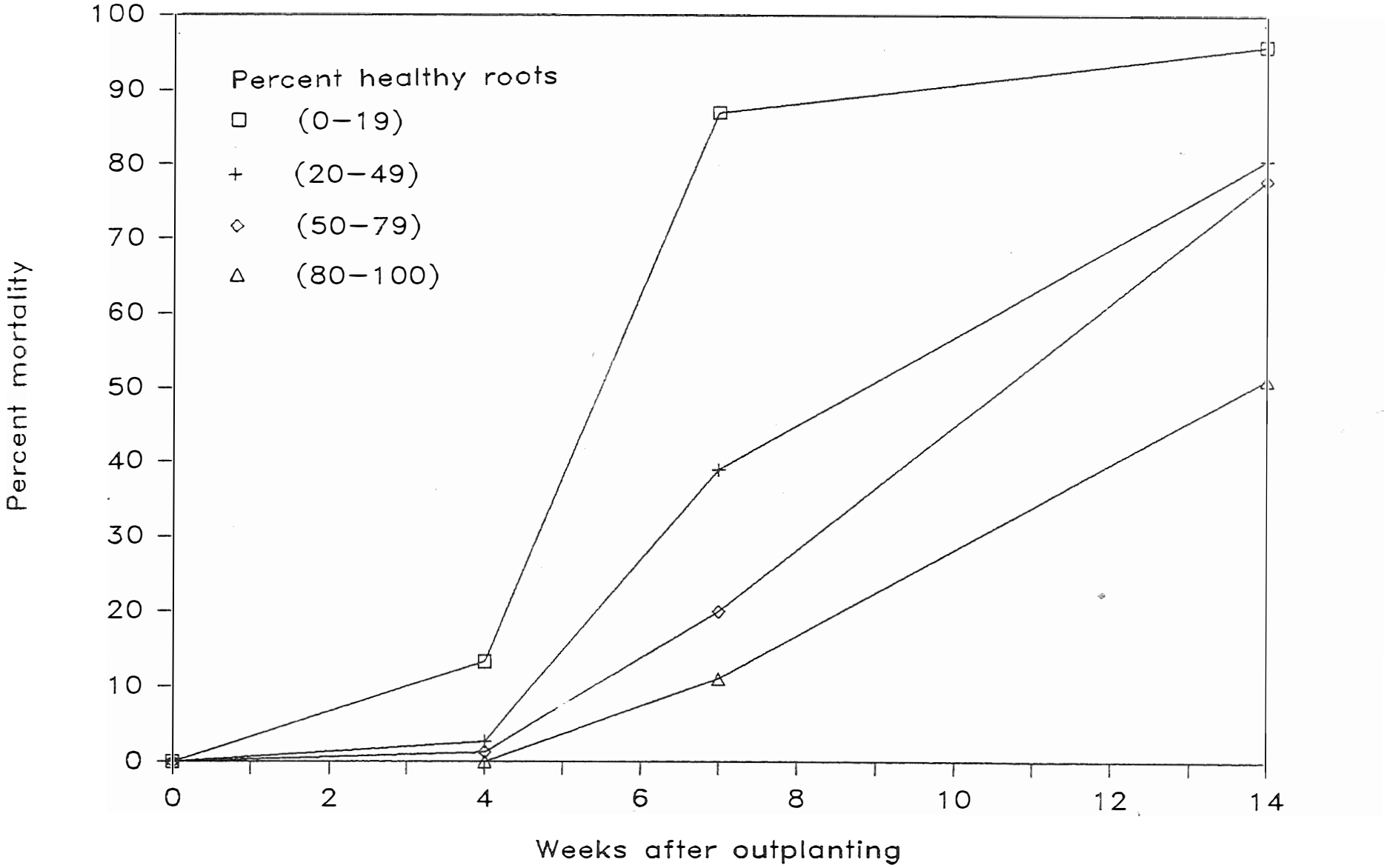


Figure 15. Accumulative percent of dead 3-0 white pine seedlings with various percentages of healthy roots.